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VOL. XXI. REGULAR EDITION NO. 587.

ARCHITECTURE

ENGINEERING

DECORATION

CONSTRUCTION

TICKNOR & COMPANY

BOSTON · MASS.

CONTENTS.

Editorial Summary.
Ancient and Modern Light-houses. —X.
Pictures of the Season in New York. — II.
Earthquakes.
Utilization of Town Sewage by Irrigation. — III.
Communications.
Notes and Clippings.
Trade Surveys.

ILLUSTRATIONS.

The First Episcopal Church, Baltimore, Md.
[Gelatine Print issued only with Gelatine and Imperial editions.]
Competitive Design for the Carnegie Library, Pittsburgh, Pa.
Mercery Lane, Canterbury, England.
Spectacle-Reef Light-house.

THE CELEBRATED

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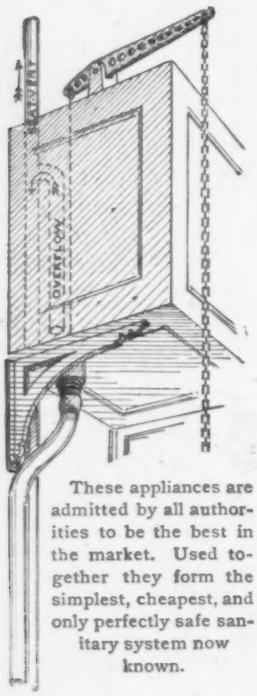
APPLIANCES.



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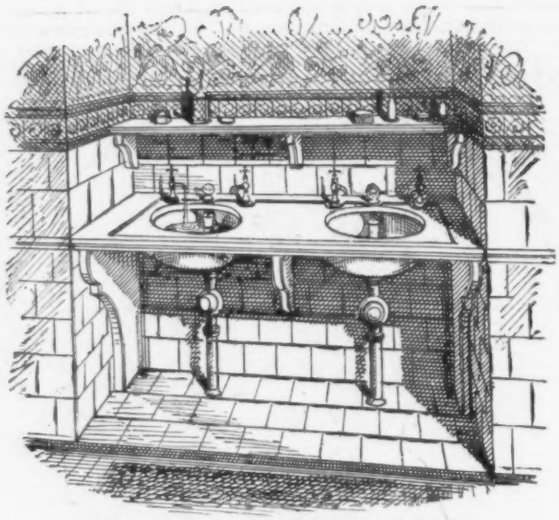

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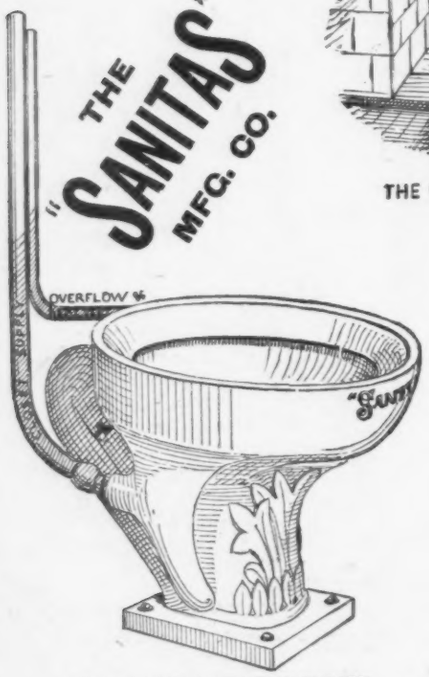

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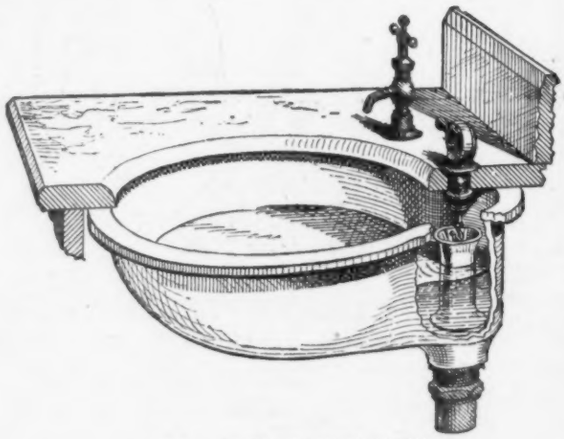

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CONTENTS.

SUMMARY: —

Schemes for enlarging the Massachusetts State-House. — Licensing Masons in New York. — The Moral Responsibility for Railroad and other Accidents. — Eyesight as it is affected by School Methods and Buildings. — A Norwegian Method of Preserving Telegraph-poles for Decay. 145

ANCIENT AND MODERN LIGHT-HOUSES. — X. 147

PICTURES OF THE SEASON IN NEW YORK. — II. 148

THE ILLUSTRATIONS: —

The First Methodist Episcopal Church, Baltimore, Md. — Competitive Design for the Carnegie Library, Pittsburgh, Pa. — Mercery Lane, Canterbury, England. — Spectacle - Reef Light-House. 150

EARTHQUAKES. 150

UTILIZATION OF TOWN SEWAGE BY IRRIGATION. — III. 152

COMMUNICATIONS: —

Reproducing European Woodwork in America. — Device to prevent Water-back Explosions. 155

NOTES AND CLIPPINGS. 156

TRADE SURVEYS. 156

THE project for enlarging the Massachusetts State-House at the smallest possible expense is still agitating the minds of various clever persons in Boston. One of the most prominent members of the City Government, with a painstaking zeal for the interest of the city which is at least worthy the admiration of the tax-payers, has devised a plan by which the city can present to the State a large vacant lot, for which it has now no use, on the understanding that the State will contribute the money for securing a considerable additional amount of land, which, with the city's lot, will provide space enough for almost any desirable enlargement of the capitol building. We do not pretend to know enough about the subject to say whether Mr. Whitmore's plan is a good one or not, although it seems to be extremely well-considered and practical. According to the newspaper reports, his scheme contains, however, one amusing suggestion, to the effect that owners of estates adjoining the property of the State should be forbidden by law to erect structures on their land calculated to dwarf the State-House. This method of maintaining the dignity of a diminutive building with august associations strikes us as worth remembering, not only for its novelty, but the extent of the applications which can be made of it. Just what are the dimensions which a Boston mansion cannot exceed without "dwarfing the State-House" it would be interesting to know; and if the proprietors of lots in the neighborhood can be prohibited from erecting structures of more than the dimensions which the collective wisdom of the lawyers and legislators of the Commonwealth decide to be without dwarfing effect on that cherished memorial of the past, we do not see why they cannot, with considerable advantage to the effect of the State-House, and an immense saving of counsel fees, be compelled to pull down at once all the buildings on their land, and leave it bare, consoling themselves for their loss of rent by contemplating the proportions of the sacred structure, made doubly majestic by being illuminated with what Mr. Ruskin would call the Lamp of Sacrifice. We are not without apprehension that the adjoining proprietors may not accede readily to this arrangement. There is no doubt that the people who do not own lots on Beacon Hill, and who constitute a large majority of the population of the State, would see very clearly the fitness and necessity of this slight submission on the part of the minority to the wishes of their brethren, but if the minority proved contumacious, there might be difficulties, which we dislike to contemplate, in reducing them to obedience, and we doubt if even the beauty of the Massachusetts State-House is worth preserving at the expense of the rights of citizens. That the people of the Bay State should be fond and proud of their Capitol we can understand well enough, and no one would be better pleased than ourselves to see it cherished and guarded by all possible evidences of care and regard; but its dignity cannot be enhanced by assaults upon the property of its neighbors, or by compulsory humiliation inflicted upon estates near by. We are told in proverbs of a land where a cat might look at a king. The Bostonians have a wise and good king, it is true, but small and antiquated in figure and complexion, and, as it seems to us, some of them have an idea that by admitting only very small cats to view their sovereign, they can spread, in the outside world, the idea that he is of colossal size and perennial youthfulness.

A NEW and rather startling symptom of the increase of public sentiment in favor of requiring certain guaranties of capacity from those who undertake to do work upon the proper execution of which the public safety may depend, is to be found in the introduction of a bill in the New York Legislature, providing that the mayor of each city in the State shall, within thirty days after the passage of the act, appoint a commission of five experienced persons, who shall determine the competency of every person who may desire to secure a license as a mason builder. We suppose that, as a corollary to this provision, no one is to be allowed to practise the art of masonry, in cities provided with commissioners, who cannot show a proper license; and it is specified that one of the privileges of the commission shall be to revoke licenses on occasion. The bill is introduced by Senator Griswold, on the recommendation of the New York State Convention of Master-Builders, which sat at Albany last month. We should say that it had not much chance of becoming a law, simply from the absence of the organized and energetic advocacy which is usually needed to carry out legislation having no political or popular interest, and which the mere recollection of the desire of a past convention is very far from resembling; but on many accounts the proposed statute would be an excellent one. Two centuries ago, when nearly every one lived in a little wooden house, two stories high, at most, in the framing and raising of which the whole neighborhood participated, no one thought of requiring a certificate of competency from those who erected it, to make sure that it was so built that it would not fall down on the owner's head, although we have seen cases where this might have been done with advantage. Now, however, people live and do their work in buildings four, five, six or eight stories high, constructed of brick, pierced, balanced, tied and cemented in ways about which the untechnical citizen knows nothing except that if the balancing, tying or cementing is improperly done, the structure will probably sooner or later come down, and that those who happen to be in it will suffer. Careless people comfort themselves by thinking that the chances are against their being in the building at the time of the crash, but the thought occasionally comes to the prudent ones that it would be an excellent thing to be sure of the reasonable solidity of the edifices in which they trust themselves. For those engaged in other employments to know anything of value in regard to the modern art of construction is difficult, and to judge with certainty in regard to works of construction is for them practically impossible; and they feel, as they do when submitting themselves to a doctor's or a plumber's treatment, that they would be very glad to have the protection against malpractice in building which the law affords them against malpractice in the two other arts. The licensing of architects would be one step in this direction, and it seems not unlikely that this step will soon be taken. The licensing of builders would be a fitting, and almost a necessary supplement to that of architects, but it would be opposed, directly and indirectly, by such a host of Buddensieks, capitalists and others interested in the worst, cheapest and most ignorant sort of building that can be made to stand up until a tenant or a purchaser comes along, that it is nearly hopeless to expect such legislation in this generation.

WHERE is little doubt that the Bussey Bridge was badly designed, and that it contained structural defects, which, even if they did not actually cause the recent accident, sooner or later, under what seems to have been the not too careful inspection of the railroad officials would have brought about the fall of the bridge, and there seems, too, to be evidence that the rolling-stock was not what a wealthy railroad should use even in "working-men's trains." For these shortcomings there is a legal responsibility against the proper enforcement of which we have no desire to raise our voice. We do, however, mean to make a protest against the course pursued by the pharisees of the press who lay so much stress on the *moral* responsibility of the owners of property which occasions loss of life. In the

abstract there should be, of course, a moral accountability for all disasters; but the owner who will build a combustible structure, the merchant who will allow smoking in his warehouse, the parent who will send to school a child from a home where a contagious disease is raging, the legislators who fail to enact perfect laws, the editors who seek to regulate all human affairs, and force them to take the shapes and limits of their own imperfect knowledge, are not the ones to take up the rôle of avenging angels. There are accidents which, humanly speaking, are inevitable: they must happen, not because they could not have been prevented, but because the millennium has not yet arrived. Railroads are peculiarly liable to this class of mishaps, and the wonder is not that they do happen, but that they do not happen oftener. If we moderns will insist on travelling over the face of the earth at forty or fifty miles an hour, knowing as we do how slight a defect will cause disaster, we believe that each of us voluntarily assumes a moral responsibility as great as that of the railroad, and that there would be abstract justice in a law that should make the purchase of a railroad ticket a release to the railroad from all claim for indemnity in case of injury. If a passenger wishes to secure himself, he can take out an accident-insurance policy, and if the public wishes to protect itself, so far as possible, it can create a governmental body with power to compel every railroad to keep its road-bed and rolling-stock in really safe condition, or else cease to act as common carriers. A railroad, one of whose trains could legally run at fifty miles per hour, while the next one could not exceed a rate of five miles without subjecting the road to heavy fine, would soon find money to buy improved rolling-stock for the second train, and so with roads and bridges. The Boston & Providence Railroad will probably have to pay heavy damages, but we hope these will be assessed fairly, and not in a spirit of revenge.

DR. LINCOLN, of Boston, the well-known writer on school hygiene, has written recently for the *Sanitary News* some suggestive papers on his favorite topics, many points in which merit the attention of architects. His most interesting paper in this respect is perhaps that on the hygiene of the eye, a subject, the importance of which may be appreciated by reflecting that in Germany, whose schools are models for the imitation of the civilized world, sixty-two per cent of all the pupils in the advanced schools have become permanently near-sighted, to the serious detriment of the usefulness and comfort of the rest of their lives. In New York, out of nearly three thousand children examined by Drs. Derby and Loring, twenty-seven per cent of those just completing their school-life were found to be near-sighted. According to Dr. Loring, although the greater part of the trouble is with German children due to the severity of the study which their schools demand, something is also to be laid to the account of the unwholesome mode of living, and neglect of out-door exercise common in Germany; but it should not be forgotten that if the habits of life of the Germans are bad in comparison with ours, which we are not quite ready to admit, they far surpass us in the systematic physical training which they unite to mental discipline, and, although young New York children may possibly be more active, and fonder of out-door play, than their German contemporaries, the latter generally gain as they grow up in firmness of muscle, erectness of carriage, and power of digestion, while the New Yorkers deteriorate in these points, until the first scholar of his class in an American college, thin, stooping and nervous, although he may not wear spectacles, appears to very little advantage beside the manly, comfortable figure of a German Doctor of Philosophy.

THE Germans are quite aware of the sacrifice in one point of physical perfection by which they now secure mental development, and are hard at work upon the problem of making it possible for children to study long and intently, day after day, without changing the focal length of their eyes. They have already done much toward its solution, and other people will, it is to be hoped, follow them closely, until myopia, like other diseases due to avoidable causes, has become a tradition of the past. How great is the need of controlling school-children in such a way as to prevent the acquirement of habits by which the eyes are permanently affected, may be judged from an observation made by Dr. Lincoln himself, who says that he once saw a whole room-full of children writing, with their eyes at an average distance from their paper of less than three inches. An hour of work in such a position would do irreparable injury to most person's eyes, and a teacher who would permit children to endanger their sight in this way ought himself to be taught better at once. In German schools it is not uncommon to have bars fixed to the front of their desks, in such a way that the pupils cannot bring their eyes within fifteen inches of a writing or lesson book lying on the desk; and all oculists often assist the formation of good habits in children with myopic tendency by placing a light frame over their shoulders, which prevents them from holding their books or work too near their eyes; and it is much to be desired that all persons of school age should be guarded in some such way from the acquisition of what is agreed by physicians to be a needless and abnormal habit. According to Dr. Lincoln, the weak or dim vision which frequently leads to myopia, through the effort made to see more distinctly by bringing the eyes nearer the object, may be due to physical weakness, such as that which follows recovery from a fever, or the natural relaxation of the vital forces in early morning, before breakfast has supplied the body with means of resistance to adverse influences; or to congestion in the head, caused by collars or clothes too tight around the neck, or to a stooping or reclining position, which disposes the blood to flow more freely than usual to the head; or to imperfect light, including both the deficiency of illumination which renders it difficult to distinguish the shape of the letters, and the dazzling, due to sunlight on the page, or the contrast of a blackboard beside a window, which causes dimness by confusing the impression on the retina. To avoid with success the disease to which these causes lead, the school-room or study should be lighted according to the rules which every architect knows; and care should be taken never to allow children to read while lying down, or with the sun shining on their book or desk. The paper or page should be maintained at a distance of about fifteen, or, as some authorities say, at sixteen inches from the eye, and rest should be frequently taken by looking away from the book. Dr. Lincoln makes the excellent suggestion that charts in large type might with advantage be used in teaching classes, both as avoiding the necessity for a certain amount of poring over books, and, we might add, to rest the eyes by allowing them to return for a time to the ordinary focal length; and we are disposed to think that the use of such charts, assisted, perhaps, by the drawing of maps or sketches, or even writing, from large copies placed at a distance, might be made of very great assistance in promoting good habits among children inclined to myopia, and even in restoring eyes which had become somewhat affected. We have ourselves often noticed that an hour or so spent in trying to make out distant objects at sea, or from the top of a hill, would result in a change of the focal length of the eyes which was noticeable for a day or two afterward in the increase of the distance at which a book could be read with comfort; and the alternation of the muscular action of the eye from that necessary to lengthen it, to accommodate its focus to rays proceeding from an object fifteen inches away, to the flattening required to accommodate it to rays from one at a long distance, is, as every sketcher knows, a pleasant relief, which might, if systematically followed, do much to keep young and impressible eyes in good condition; while the effort, for children already slightly near-sighted, to see the distant charts, might, if the strain were prevented from being too severe by giving them favored positions, assist materially in their cure.

THE *Technologiste* describes a simple method of treating wood with preservative solutions, which is applied in Norway to telegraph-poles. After the poles are set in place, a man goes from one to another with an auger, with which he bores a hole in each post, beginning at a point about two feet above the ground, and boring obliquely downwards, at as small an angle as possible, with the axis of the post, until the point of the auger reaches the centre of the stick. The auger-hole should be an inch in diameter, and, in telegraph-poles of the ordinary size, will hold easily four or five ounces of sulphate of copper, which is put into it in the form of coarsely powdered crystals, and the opening then stopped with a plug, the end of which is left projecting as a handle, so that it can be pulled out and replaced. Just what action it may be that then goes on in the interior of the stick, no one pretends to say; but it is found that the crystals of copper sulphate disappear slowly, so that every three or four months the charge must be renewed; while the wood, both above and below the auger-hole, even to the very top of the pole, gradually assumes the greenish tint due to the presence of copper in the pores.

ANCIENT AND MODERN LIGHT-HOUSES.[1] — X.

SPECTACLE REEF LIGHT-HOUSE.

WHERE is but one other light-house in the United States of the same type as Minot's. This one is situated on Spectacle Reef, Lake Huron, and is not properly a *sea*-rock light-house, as the destructive agencies to which it is exposed are not sea-waves, but chiefly ice-packs.

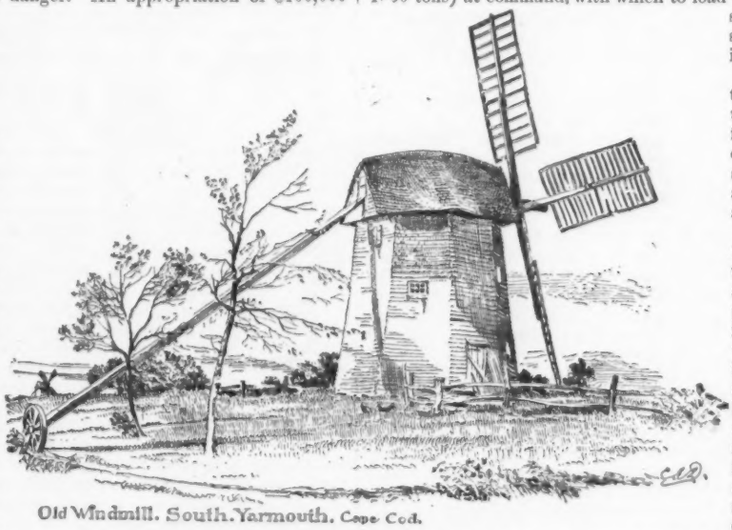
It stands on a reef at the northern end of Lake Huron, off the eastern end of the Straits of Mackinac. There are two shoals of limestone rock *in situ*, covered with boulders so situated with respect to each other as to resemble a pair of spectacles. The light-house stands on the southerly end of the most northerly shoal.

In 1868 the Light-house Board recommended an appropriation to erect this light, estimating the cost to be about $300,000. The wreck of two vessels at one time, the preceding fall, gave emphasis to its necessity, as these wrecks involved the loss of a sum greater than that necessary to mark this danger. An appropriation of $100,000 was granted to commence the work, and next year an additional sum of $100,000 was appropriated.

An examination of the site showed that the least depth of water on the shoals was about seven feet, and at the locality selected for the light-house, rock was found at a depth of eleven feet.

The nearest land is Bois Blanc Island, about eleven miles distant. A depot for this work was established at Scammon's Harbor, in Les Cheneaux, sixteen miles from the site.

The greatest exposure to waves is from the south-east, the sea having a fetch of about one hundred and seventy miles. Their force, however, is not so great as to require any great precautions to insure stability. But at times currents are developed here having a velocity of from two to three miles per hour, and during the winter season serve to move to and fro ice-fields two feet thick and thousands of acres in extent. This ice, formed in fresh water, is of extreme solidity, and when in motion has a living force which is almost irresistible. The object was, therefore, to oppose to it a structure against which the ice would first be crushed, and then its motion so impeded as to cause it to ground upon the shoal itself, thus forming a barrier against subsequent action.



Old Windmill. South Yarmouth. Cape Cod.

To give some idea of the necessity for this, it may be mentioned that in the spring of 1875, when the keepers returned to the station, the light being discontinued during the winter months, they found the ice piled up against the light-house, seven feet above the sill of the door-way, which is twenty-three feet above the lake, and they were only able to obtain entrance to the house by cutting their way through the ice.

The plan contemplated building first a crib-work or "protection pier," with a large central opening, in which was to be placed a coffer-dam. The water was then to be pumped from the coffer-dam, the rock levelled, to prepare it for the foundation of the light-house, and then the light-house was to be built of stone, carefully cut and strongly fastened together.

The protection pier was built at Scammon's Harbor during 1870–71. In the former year a careful survey was again made at the site, when it was discovered that the hull of the schooner *Nightingale*, wrecked the preceding fall, covered, with her cargo of iron ore, a good portion of the bed of rock on which the tower was to stand. As there was no other place on the reef where bare bed-rock could be found, except in eighteen feet of water, it was necessary to remove that portion of the wreck covering the area required for the coffer-dam.

It was intended to build the light-house of granite, but the contractor utterly failed to furnish this stone. Limestone from Marblehead, Ohio, was therefore purchased in sufficient quantity to continue the work. The coffer-dam was framed at Detroit, Mich., during the winter, and was taken to Scammon's Harbor on the opening of navigation of 1871, to be in readiness for use as soon as the crib should be placed in position.

The original intention was to put this crib in position in four sections, but upon further consideration it was decided to attempt placing it as a whole upon the reef. This was successfully accomplished as follows: four temporary cribs, each fifteen by twenty-five feet, of round timber, were placed in from eight to ten feet of water, in a line corresponding with the proposed eastern face of the pier of protection, and filled to the level of the water with ballast-stone. They were then connected together and decked over. On this deck were placed about seventy cords of ballast-stone, ready at the proper time to be thrown into the pier of protection. The two lower courses of this pier, fastened together with screw-bolts, forming a raft, were towed to the site and moored directly over the position to be occupied by the finished pier. Its position was marked upon the temporary pier mentioned above, and soundings taken at intervals of two feet along each timber in the raft, thus obtaining accurate contours of the surface of the reef within the limit of those timbers. The raft was then towed back to the harbor, hauled out upon ways, and by means of wedges of timber the bottom was made to conform to the surface of the reef. The raft, now become the bottom of the pier of protection, was then launched and additional courses of timber added, until its draught of water was just sufficient to permit its being floated into position on the reef.

Meanwhile five barges at the harbor had been loaded with ballast-stone, making, with that at the temporary pier, 290 cords (about 1800 tons) at command, with which to load the pier of protection and secure it to the reef, as soon as it should be placed in position.

This crib was ninety-two feet square, and between eleven and twelve feet high, with a central opening forty-eight feet square. It thus occupied a space nearly a quarter of an acre in extent.

On the evening of the 18th July, 1871, everything being in readiness, and the wind, which had previously been blowing freshly from the north-west for three days, having somewhat moderated, at 8 P. M. two tugs took hold of the immense crib, and started to tow it to the reef, fifteen miles distant, followed by the fleet of stone barges. The construction-scow, with tools, etc., on board, was towed with the crib. At 2 A. M., next day, the fleet hove-to off the reef, awaiting daylight, and the abatement of the wind, which had again freshened up. At half-past six, it having moderated, the pier was placed in position, with considerable difficulty, and after being secured to the temporary pier, and to moorings previously set for it, all hands went to work, and by 4 P. M. had succeeded in throwing 1200 tons of stone into the compartments.

By this time the wind had so increased that the rising sea made it necessary to stop work, but early next morning the rest of the reserve stone was put into the compartments.

After the pier was in position, a schooner was moored on the reef, to serve as temporary quarters for the workmen, who proceeded at once to build up the pier to the required height, twelve feet above water. More stone was brought, and by the 12th of September the pier reached its full height, and, by the 20th, quarters for the workmen were built upon it, when the schooner was discharged. A diver was then employed to clear off the bed-rock within the opening of the pier, and the coffer-dam was commenced.

This coffer-dam consisted of a hollow cylinder, forty-one feet in diameter, composed of wooden staves, each four by six inches, and fifteen feet long; it was braced and trussed internally, and hooped with iron externally to give it the requisite strength. It was put together at the surface of the water, and, when complete, was lowered to its position by means of iron screws.

As soon as it rested on the rock, whose contour was quite irregular, each stave was driven down to fit as closely as possible, and a diver then filled with Portland cement all the openings between its lower end and the rock. A loosely-twisted rope of oakum was then pressed closely down outside the lower end of the coffer-dam, and outside this a larger rope made of hay.

The pumping-machinery having been got ready in the meanwhile,

[1] Continued from page 102, No. 583.

the coffer-dam was pumped dry, and on the same day, October 14, a force of stone-cutters descended to the bottom and commenced the work of levelling-off the bed-rock so as to prepare it for the first course of masonry.

The rock sloped from the west to the east, and, in order to make a level bed, it was necessary to cut down about two feet on the highest side, involving a large amount of hard labor, and rendered still more difficult by the water forcing its way up through the seams in the rock. This work was finally accomplished, as much care being taken to cut and level the bed as with any of the masonry courses. The first course of masonry was set and completed October 27. The water forcing its way through the seams gave much trouble as it disturbed the mortar; for this reason water was let into the dam every evening and pumped out in the morning, to give the mortar time to harden during the night. The mortar was composed of equal parts of Portland cement and screened silicious sand, and became as hard, or harder, than the bed-rock or the stone of which the tower was built.

As the weather now became boisterous, frequent snow-squalls interfering with the work, it was determined to close operations for the season, so everything was put in safety for the winter, and by the end of October all the men had left the rock except two, who were left to tend the fog-signal and the fourth-order light, which had been erected on the men's quarters; they were taken off at the close of navigation.

The degree of success of this model coffer-dam may be inferred from the fact that, though provided with pumps having an aggregate capacity of 5,000 gallons per minute, not more than a capacity of 700 gallons was used, except when emptying the coffer-dam, and then only to expedite the work; once emptied, a small proportion of this capacity was ample to keep the coffer-dam free from water, and this at a depth of twelve feet of water, on rock, at a distance of eleven miles from the nearest land. Every one connected with this work may well feel a just pride in its success.

The following season opened a month later, so work was not resumed at the harbor until the 3d of May, 1872, and upon the reef on the 20th of the same month. On May 13 the ice was a compact mass of some feet in thickness, and masses of ice lay on top of the pier itself. As soon as possible the ice was cleared away, and the work of setting the additional courses began.

By the close of the season the work had been carried to the seventeenth course inclusive, completing the solid portion of the tower. In September there was a violent storm, and the following account will give some idea of its violence and the damage done:

"The sea burst in the doors and windows of the workmen's quarters, tore up the floors and all the bunks on the side nearest the edge of the pier and the platform between the quarters and the pier. Everything in the quarters was completely demolished except the kitchen, which remained serviceable. The lens, located on top of the quarters was found intact, but out of level. Several timbers on the east side of the crib were driven, in some four inches, and the temporary cribs were completely swept away. The north side was so completely filled up that the steamer can no longer lie there. A stone weighing thirty pounds was thrown across the pier; but the greatest feat accomplished by the gale was the moving of the revolving derrick from the northeast to the southwest corner. At three o'clock in the morning the men were obliged to run for their lives, and the only shelter they found was on the west side of the tower. The sea finally moderated sufficiently to allow them to seek refuge in the small cement shanty standing near the southeast corner of the crib. Many lost their clothing."

During the following winter the workmen's quarters, from which the light had been exhibited, was carried away by the ice, and together with the lantern was totally destroyed. This was not unexpected, and in view of the probable result, the lens had been removed and stored in a place of safety. The fog-signal was uninjured and was sounded whenever required. Work was continued during the working-seasons of 1873–4, and the light was exhibited for the first time on the night of June 1, 1874.

The exterior of the tower is a frustum of a cone, thirty-two feet in diameter at the base and eighteen feet at the spring of the cornice, eighty feet above the base. The cornice is six feet high and the parapet seven feet. The focal plane is four feet three inches above the parapet. Hence the entire height of the masonry above the base is ninety-three feet, and of the focal plane ninety-seven feet three inches.

The tower is solid to a height of thirty-four feet; above this it is hollow, and divided into five stories, each fourteen feet in diameter. The walls of the hollow portion start with a thickness of five feet six and three-tenths inches, and are eighteen inches thick at the spring of the cornice. The whole interior is lined with a brick wall four inches thick, separated from the outer wall by an air-space of two inches. All stones below the cornice have a uniform thickness of two feet. All sashes, shutters, and doors are made to open outward, which admits of such an arrangement of the rabbets as to effectually prevent the entrance of water at the window and door openings.

The stones in the solid portion are cut to form, in the simplest manner, a most complete lock upon each other in each course, and the several courses are bolted to each other with wrought-iron bolts two and one-half inches in diameter and two feet long. The lower course is bolted to the rock with bolts three feet in length, which penetrate the rock to a depth of twenty-one inches. All the bolts are wedged at each end with conical wedges, and all bolt-holes are filled solidly with pure Portland-cement mortar.

Above the solid portion no bolts are used except in the first course, but on the build of each course a ribbon has been cut, fitting into a corresponding recess in the course above.

The reader will notice the similiarity of the "bond" in this tower to that used at Minot's Ledge.

Deducting the time while work was suspended for the winter, and that consumed in giving notice to mariners, the aggregate working-time was twenty-four months, but as at least two week's time was lost at the beginning and end of each season getting ready for and in securing the work, the actual available time did not exceed twenty months.

The total cost, including the steamer and appliances of every kind was, in round numbers $375,000.

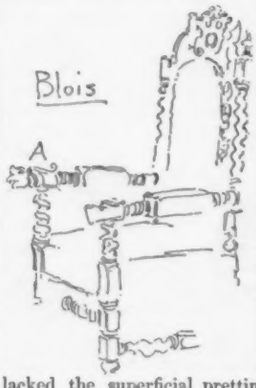
The crib and coffer-dam were designed by Col. and Bvt. Brig.-Genl. W. F. Reynolds, and the tower by Lt. Col. and Bvt. Brig.-Genl. O. M. Poe, both of the Corps of Engineers of the United States Army. The latter officer had charge of the difficult part of the work until the foundation was brought above water. The tower was completed by Maj. and Bvt.-Brig.-Gen. Godfrey Weitzel, Corps of Engineers, since deceased. Any account of Spectacle Reef Light-House should give much credit to Mr. Anthony L. Ederle who was the Superintendent of Construction from the beginning until the completion of all work of any difficulty.

The construction-pier, which has been repaired from time to time, is still standing, and is most useful as a landing-place and a site for the steam fog-whistles.

Of late years, however, it has become much deteriorated and is beyond economical repair; next summer the Light-house Board will probably build an iron caisson filled with concrete adjacent to the tower, to form a foundation for the fog-signal apparatus, after which it will be a matter of little moment whether the construction-pier is destroyed or not.

[To be continued.]

PICTURES OF THE SEASON IN NEW YORK.[1]—II.



FEWER pictures than last year were shown this winter at the Water-Color Exhibition. As this meant that a more careful selection had been made among the submitted drawings, the collection was of higher average excellence, and contained a smaller number of distinctly bad attempts. Some of our best aquarellists were absent including Mr. Abbey; and others, like Mr. Winslow Homer, were represented by comparatively unimportant works. But Mr. La Farge sent three or four exquisite little figure-drawings, among which was a first-fruit of his recent journey in Japan — a marvellously painted "Masked Dancer." Mr. Alden Weir was represented by a child's portrait, which lacked the superficial prettiness often thought essential to such work but was distinguished instead by a serious and dignified expression of character, secured without the least exaggeration of infantile simplicity; and by several figure-compositions among which was one called "Consolation." Showing the figures of a young mother in deep mourning and a little child, it was the most noteworthy picture in the exhibition as regarded deep and vital meaning — very clear in suggestion and infinitely touching, full of sentiment yet beautifully simple and devoid of all taint of sentimentality. Mr. Kappes sent a most admirable negro *genre;* Mr. Léon Moran some dainty yet vital and expressive eighteenth-century figure-subjects; Mr. Homer Martin some charmingly poetical English landscapes; Mrs. Nicholls a strong and interesting if, in the expression of character, not wholly successful scene from the "*Scarlet Letter*"; and Mr. Robert Blum sundry little Dutch figure-subjects, admirably fresh and free in their execution and in the way they rendered character by a process of briefest suggestion. The most striking thing in the collection, technically considered, was Miss Greatorex's large still-life called "Russian Tea"; and it was as fine in color and composition as in handling.

The Society of Etchers exhibited, as usual, in conjunction with the aquarellists. But their collection was not of a sort to satisfy those who have been hoping for a fulfilment of the promise our etchers suddenly gave a few years ago. The popular demand for large, showy and "highly finished" prints has turned the tide of production away from the truest goal of the art, and (though there were a few honorable exceptions) most of the contributions were larger in size than in meaning, were conceived rather in the painter's than in the etcher's spirit, and were marked by a kind of execution that was laborious rather than truly accomplished.

As a contrast Mr. Keppel has recently shown us a complete collection of the works of Millet who was the greatest etcher of modern times, if we make close adherence to the most characteristic technical qualities and use of the deepest expressional possibilities of the art our

[1] Continued from page 136, number 586.

tests. No man since Rembrandt has felt the potency of lines, as distinct from the potency of tones, so clearly as Millet. No one has conveyed so much with so few lines or made each and every stroke of the needle to bear so deep a message. No man has put such profound feeling into his etchings and no one has expressed it so forcibly or so succinctly. The collection — recently purchased from M. Lebrun in Paris — is not only complete (containing every print of every kind which Millet is known to have produced and every "stage" of each) but the only complete one which ever can be formed. Many of the prints it contains are very rare and no less than eight are pronounced by M. Lebrun's catalogue to be unique. In addition to etchings it contains lithographs, heliographs printed from glass, and wood-cuts — a few of the last not only drawn but cut by the artist himself and others drawn by him on the wood and cut by others. Those cut by his brothers are truly marvellous examples of that phase of the art which was developed in its earliest years and is so entirely different, alike in method and effect, from the phase we know to-day. The process is one of black not of white line; and the lines are very few, extremely strong and simple upon a broad untouched background. So *naïf* is the execution that one thinks perforce of the knives and planks of the sixteenth century rather than of the burins and blocks of the nineteenth. And so strong and *naïf* is the feeling expressed that thus also one is reminded far more of Dürer and his school than of modern Paris. But in the *kind* of feeling expressed there is no analogy with mediæval or renaissance moods. Millet is as much himself in these wood-cuts as in his etchings or paintings; and that self is one of the most characteristic products of modern as distinct from earlier ways of thought.

Many of the etchings show again the same subjects with which certain of his famous paintings have made us familiar. And how strong a hold these subjects had taken upon his imagination — how clearly he not only felt but *saw* them with the eyes of his mind and heart — is proved by the exact analogy in face and attitude and expression which each etched figure bears to its painted fellow. But how true was his artistic instinct, how accurately he knew and how completely he controlled the different technical methods he employed, is also proved by such a comparison. The "message" is the same, whether delivered by brush or needle. But the needle never tries to imitate the effects produced by the brush. No etching is in the true sense a reproduction of the corresponding picture. It is the same conception but translated into a different artistic tongue and as simply, frankly and characteristically as though it had not already once been told in another tongue. Seventy-seven numbers in all are included in the collection which Mr. Keppel refuses to break but offers for sale as a whole for the sum of $4,000. Considering that it is unique as well as intrinsically so interesting this price cannot be called high. Some individual or institution should surely be found to purchase it for the public, for it is just such a collection as would be of value for popular as well as for technical training. It shows the inmost soul of that artist who among all modern men had the deepest, freshest feeling and the greatest power of speaking to the noblest emotions of man; and it shows the truest, most individual kind of success which, technically speaking, can be obtained with the etcher's tools.

A greater artist than Millet, even, has been revealed to the New York public this winter, not in a long series of works but in what will sometimes afford as clear if not as full a revelation — in a single canvas that is really representative. It is nearly two years, I believe, since Mr. Schaus purchased from the Duc de Morny, Rembrandt's famous "Gilder." But no one had seen it till the early part of this winter when it was shown for a short time in his store. Now it hangs in his home, among certain choice modern canvases — so good that even a Rembrandt does not put them out of countenance — and may there be seen from time to time by those who are fortunate enough to secure cards of invitation. Much as one had heard of it, distinctly as one had known it to be not only an unquestioned original but a famous and in the truest sense characteristic example of its author's best work in portraiture, the sight of it was a surprise of the happiest sort. For it is intrinsically finer than words could suggest, and is in absolutely perfect condition. The Rembrandts I know best are those in the Dresden collection — many in number and, as regards the portraits, most excellent in quality. But none of the Dresden Rembrandt portraits was ever so fine as Mr. Schaus's in conception and execution save only the well-known "Saskia with the Pink" which is almost contemporaneous in date; and not one of them all is in nearly such good condition. Had the "Gilder" been painted yesterday it could not be fresher, more flawless or more evidently free from the cleaner's or the "restorer's" ravages. All that time has done has been in the way of improvement — for it seems as though its beautiful golden tone, so clear yet so deep, so pure yet so tender, could not have been the immediate creation of any human hand, even a Rembrandt's. Painted in those middle years which were the best years of the artist's life, it shows his method at a time when it had outgrown the somewhat over-accented definition of earlier years but had not yet developed into the extreme breadth (passing at times into bold summarization) of a later period. As a manner, nothing could be more perfectly balanced, more complete, more consummately true and at the same time artistic. Everything is told about every item of the face — we see the man exactly and wholly as we should have seen him in life. But nothing is over-emphasized or so presented as to injure breadth of effect. We see all details but we see them as we do in a living face — almost forgetting them in noting the total result in its form and color and expression. As a piece of drawing the work is far above all praise. And in color it is surpassingly beautiful. It was a few years after the date which this picture bears that Rembrandt developed his coloristic power most brilliantly — painted those dusky, sun-streaked interiors lighted with jewel-touches of gorgeous hues which are so different from the broadly massed results of the great Venetians yet are absolutely on a par with them in coloristic beauty. But even when this portrait was painted he had complete control of the soberer resources of his palette and had perfectly developed that "golden-brown tone" which is considered the distinguishing mark of his best period. A painter who wants to know what *good painting* means will find the term perfectly explained in this picture — which is so well painted that it seems to be painted in the only possible way; seems to say, this is the way to do it — why does any one ever do differently? And one who wants to know what good tone and color and atmosphere mean, and what it means to paint character and soul as well as body will also find the answers here, as convincingly given as by any portrait in the world. The beauty of it all is that it looks so simple, so natural, so easy, so *necessary*. But this, I need hardly say, is the aspect which distinguishes a very great work of art in each and every department and never any but the very greatest.

"Down-town" auction-sales have been even more frequent than usual this winter, and an even higher degree of excellence has been claimed for the wares they offer. But these wares have so seldom in the past supported the claims made for them by their advertisers that even the newspapers rarely mention them except in their advertising columns and the truly art-loving public never gives them a thought. One wonders equally where all these pictures come from and where they possibly can all go to.

Up-town the season has brought out a number of collections that successively have come beneath the hammer with good pecuniary results. The first was Mr. Robinson's collection of modern pictures which professed to have great historical value as containing a systematic assortment of works by the most noted Continental masters of the century. But most of the examples were small and unimportant; some of them were not, truly speaking, representative; and the best were studies or sketches rather than finished pictures.

The Graves collection was very large and very various. Most of its contents were distinctly poor; but among them were some good French landscapes, including several admirable Michels.

The A. T. Stewart collection, still on exhibition as I write, has not excited half so much popular attention as did the Morgan collection last year — a proof that our public *has* some feeling for intrinsic excellence in art as well as for mere notoriety. For in no other respect save notoriety is this collection entitled to even a comparison with the other. Never was such a dreary waste of commonplace, broken by so many absolutely inferior works and by so few of distinct superiority. Rosa Bonheur's "Horse Fair" is worthy of its fame as an admirable, interesting, strong and serious piece of work, if not a great creation or one which shows a very individual artistic temperament. Her brother Auguste's "Forest of Fontainebleau" is still better — not so vigorous in intention or so immediately effective, but as sincere, much more individual in feeling, and far more poetical than anything Rosa Bonheur ever painted or could paint. Gérôme's famous "Gladiators" has all the excellence with which the engravings have made us familiar but not a particle more. Indeed the hardness of its execution and the disagreeable quality of its color make it less attractive than the black-and-white reproductions. But another work by the same hand, an interior with two figures, is infinitely better in color and in execution than his works are apt to be — really a beautiful as well as a clever picture. Zamacois's "Court Jesters" is another well-known and excellent picture. Benjamin Constant is represented by a fresh and brilliant Oriental scene, and Munkácsy by a modern interior which shows him to far better advantage than the big "Christ before Pilate." One or two of the Bouguereaus are good of their kind.

French landscapes are almost wholly wanting, but there is one D'Aubigny of fair quality and two Troyons — interesting, of course, but too early to be really representative. There are two pictures by De Nittis, clever but not of his best; a rather early and not very attractive Détaille; a charming fantastic Michetti; an Alfred Stevens which cannot be called very characteristic; and certain "old masters," some of which are really good as well as really old, though very surely not the work of those whose names they bear. And then there are two small and second-rate Meissoniers and the famous big "Friedland — 1807," which is as far inferior in quality and interest to a truly good Meissonier as it is superior in size. If any one has wanted to know the difference between great and merely clever painting he could not have had a better object-lesson than that afforded by a comparison between the sky of the adjacent Daubigny landscape and the sky of the "Friedland." Of course the picture is well-drawn; but it is not well composed and is extremely bad in color and weak in dramatic expression. And in execution it is sometimes empty and sometimes so over-minute as to produce a singular hardness and unreality of effect. One is curious to know who will buy it and what he will be willing to pay for it. But it certainly will not be purchased by any one who knows what a good Meissonier means and wishes to possess one.

There are many American pictures in the collection, but few of them — scarcely one perhaps except a certain little figure by Beaufain Irving — will do much to raise the spirits of the patriotic

visitors. And finally there is a good but short series of works by Spanish-Roman painters, culminating in the two gems of the collection — Fortuny's "Snake-Charmers" and his "Beach at Portici." The former is a comparatively early work, low in tone but very rich in color and admirably strong in handling. The latter is the last work upon which he ever labored and was left incomplete at his death — a magnificent rhapsody of brilliant hues pitched in a high, strong scale; a work so unconventional yet so true in its own new way, so audacious yet so earnest, so striking yet so satisfying, so vigorous yet so poetic, so strange and yet so laudable that it explains at once the enormous influence that this great and individual master has exercised upon the living generation of painters.

The collection of bric-à-brac and furniture is large but for the most part devoid of all artistic value. The catalogue of the library contains less than five hundred entries, but speaks of many fine illustrated works — among others, of the Marquis of Kingsbury's "*Mexico*" and of a copy of the "*Nuremberg Chronicle*." There are many things in the various collections which the public might gladly have owned. But as a whole they would have been more of a burden than a benefit had they been bequeathed, as many hoped they would be, to the public's keeping.

Mr. Wm. M. Chase recently exhibited and sold in our city that interesting collection of his works which was shown in Boston earlier in the winter. Every one admired the pictures, and artists and connoisseurs even more than the general public. But they did not sell for anything like their true value, while poor or bad or even unauthentic foreign works have been selling month by month for much more than theirs.

Mr. Whittredge, one of the oldest and most earnest of our landscape painters, also sold a large collection of his pictures a few days ago. And as a contrast to these we may now see the collected works of two of our youngest landscape painters — the late William Bliss Baker and Mr. Charles H. Davis. The former was a product of home instruction, and, so to say, a "realist." The latter, after studying in Boston, has spent six years in Paris under the tutelage of Boulanger and Le Febvre, and is distinctly to be called an "idealist." But Mr. Baker's prose does not lack for individuality and charm, and Mr. Davis's poetry has a very firm basis of reality to rest upon. Each is an excellent workman in his own way and it is well that our landscape art should not be developed in one way only. Mr. Baker's pictures are soon to be sold at auction and an appreciative public is to be hoped for them. Mr. Davis's are already meeting with such a public, seventeen out of fifty-three having been sold for good prices after only four days of exhibition.

M. G. van Rensselaer.

ILLUSTRATIONS

[Contributors are requested to send with their drawings full and adequate descriptions of the buildings, including a statement of cost.]

THE FIRST METHODIST EPISCOPAL CHURCH, ST. PAUL'S AND FOURTH STREETS, BALTIMORE, MD. MESSRS. McKIM, MEAD & WHITE, ARCHITECTS, NEW YORK, N. Y.

[Gelatine Print, issued only with the Imperial and Gelatine Editions.]

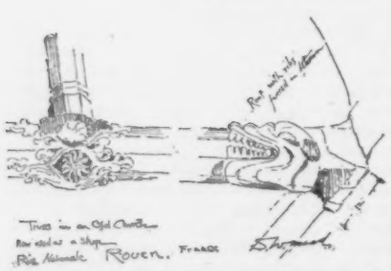
COMPETITIVE DESIGN FOR THE CARNEGIE LIBRARY, PITTSBURGH, PA. MR. J. L. FAXON, ARCHITECT, BOSTON, MASS.

MERCERY LANE, CANTERBURY, AFTER AN ETCHING BY CHARLES J. WATSON.

SPECTACLE-REEF LIGHT-HOUSE.

For description see article on "Ancient and Modern Lighthouses."

EARTHQUAKES.[1]



From all quarters have come to me inquiries about the earthquake in Charleston. Because I am a teacher of geology it has been taken for granted, quite gratuitously, that I know or ought to know, all about the earth of which the structure and history are the geologist's special objects of study. That he knows more about these than other people is possible, but that he knows all about them is unfortunately far from true. It is, however, natural that I should be appealed to for information in regard to what is the most striking of all terrestrial phenomena; and while I do not claim nor accept the title of "Professor of Earthquakes," which one correspondent seriously gives me, I acknowledge it as a part of my duty to satisfy, as far as I am able, the demand which has been made by the public. . . .

Briefly told, an earthquake is a movement caused by a shrinking, from the loss of heat, of the heated interior of the earth, and the crust ling together and displacement of the rigid exterior as it accommodates itself to the contracting nucleus. . . .

From observations in mines, and from deep borings, from hot springs and volcanoes, we have learned that the interior of the earth is intensely hot. The most satisfactory data for this conclusion are furnished by wells and mines. These are located in all the great divisions of the earth's surface: China, India, Australia, Africa, Europe, and North and South America, all have their mines or deep borings, which give fairly harmonious testimony upon this subject. They prove that after passing the plane of invariable temperature, beyond which the alternations of the seasons are not felt, the heat increases about 1° Fahrenheit for every 50 feet. For example, the well in the grounds of the Lunatic Asylum at St. Louis, is 3843 feet in depth; at 3200 feet, where the temperature was last observed, it was 107°; the State-House well, at Columbus, Ohio, is 2775 feet deep, and at 2575 feet the temperature is 88°. The artesian well at Louisville, Kentucky, is 2080 feet deep, and the temperature at the bottom is 82° summer and winter. Other wells bored in the Valley of the Mississippi and in the Eastern States furnish similar data. . . .

It may then be considered as established that all over the earth's surface, except in volcanic districts, the temperature increases about 1° Fahrenheit for every 50 feet descent. It is evident that should this rate of increase continue the temperature at the depth of fifty miles would be sufficient to melt all known substances, and the first conclusion from the observations of temperature in mines and wells was that the solid portion or crust of the earth could not be more than forty or fifty miles in thickness, and it was proclaimed that we were living on a film of solid matter, floating on a sea of molten rock. The comparative stability, however, of the earth's figure — the little effect produced by the attraction of the sun and moon — have led to the conclusion that the earth's crust is thicker than this, and it has been suggested that while the accuracy of the observations on the increase of temperature to the depth of one mile cannot be questioned, it is possible that the rate of increase to that depth is not constant below; that the increment may diminish, and therefore, the temperature of fusion may only be reached at a greater depth than has been supposed.

It has also been shown that the melting point of many substances is raised by pressure, and therefore, that the enormous weight of the overlying rocks, equivalent to 5,280,000 pounds to the square foot for every mile, may hold in coerced rigidity a considerable zone of the earth's mass composed of materials that would melt and flow on the surface at a much lower temperature than that which they now endure in a solid form. Accepting, then, the conditions imposed on the old theory of the state of the interior of the earth by pressure, and the possible diminution of the increment of temperature, we may suppose that the solid crust is considerably thicker than was formerly supposed. That it is relatively thin, however, is indicated by facts which will be cited farther on.

The increase in temperature observed in mines and deep borings means that the heat of the interior of the earth is constantly escaping to the surface, where it is radiated into space. If the outer crust were a perfect non-conductor the materials within it would always maintain a condition of thermal equilibrium throughout. It is thus evident that the process of refrigeration is progressive, and from the time when the first film of solid matter dimmed the brightness of the "glittering globe of liquid fire," the crust formed at the surface has been constantly increasing in thickness, while by the loss of heat, which is an expansive force antagonistic to gravity, the volume of the earth has been as constantly diminishing. But since the outer crust has lost its inherent heat and has become solid it no longer shrinks, though the loss of volume goes on incessantly in the intensely heated, but gradually cooling interior. As the nucleus contracts, the solid crust cannot accommodate itself moment by moment to the loss of volume, for it resists by its rigidity, and is brought into a state of strain. This is relieved from time to time, whenever it passes the resistance of the materials composing the crust, by a crushing together and displacement of the surface rocks. These are *faulted* or *folded;* that is, are either thrown into great waves by lateral pressure, or the arches are broken and fissures are produced at right angles to the line of thrust. The rocks forming the sides of these fissures slide on each other, forming what geologists call *faults*, in which the "throw" or displacement sometimes amounts to many thousand feet. Earthquakes, mountain chains and volcanic eruptions may all be considered as consequences of this readjustment. Mountain chains are great lines of fracture in the earth's crust along which rocks, before nearly horizontal, are raised into ridges by lateral pressure. They have been compared, not inaptly, to the wrinkles formed in the rind of a fruit when it loses its volume by drying. . . .

Another thing about mountain chains is not so generally known as that they are lines or belts of folded and fractured rocks, and that is that they are the products not of moments or even years, but of ages. The lines of fracture which are marked by mountain chains

[1] Extracts from a paper by Prof. J. S. Newberry in *The School of Mines Quarterly*, for October, 1886.

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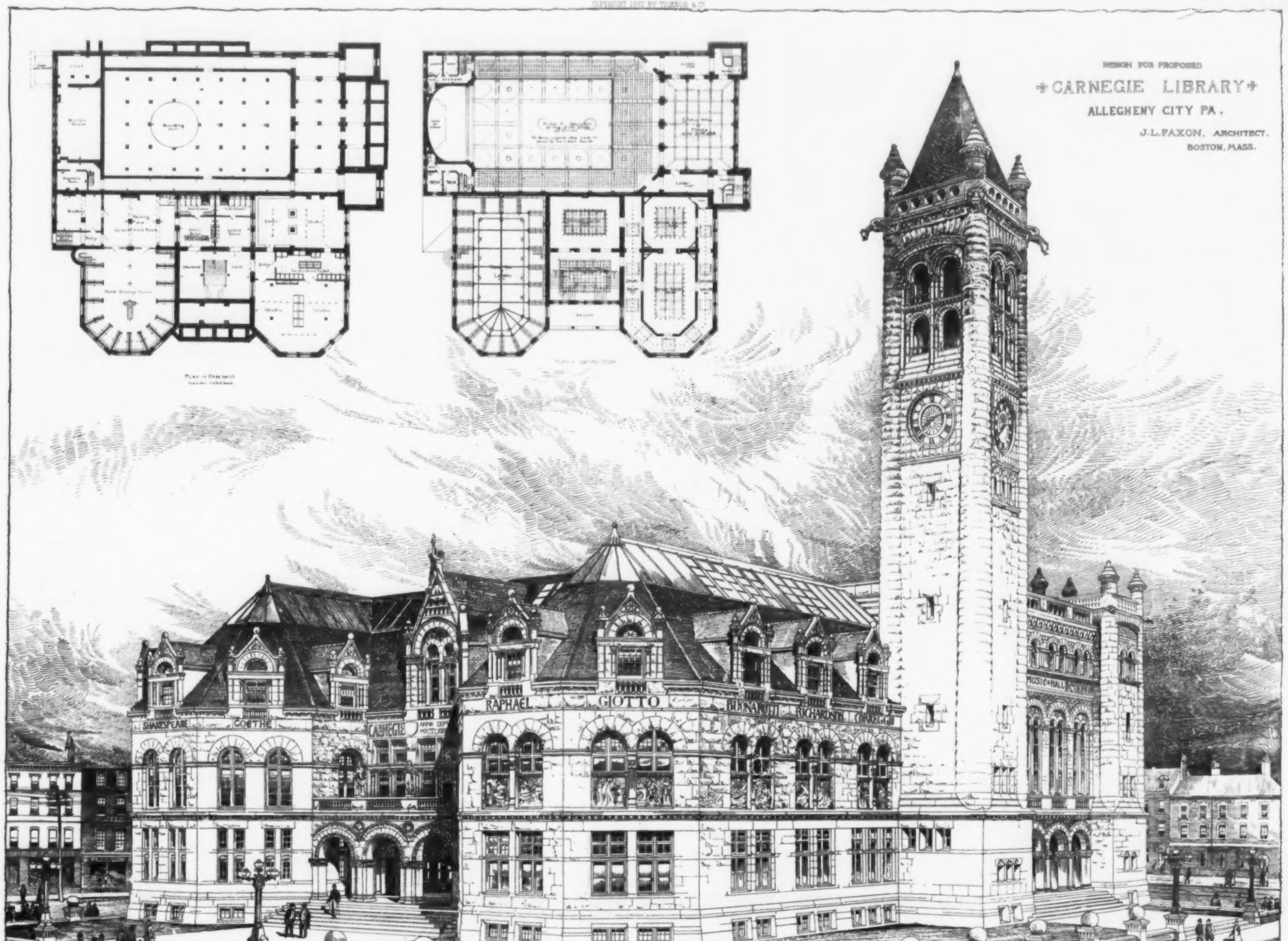
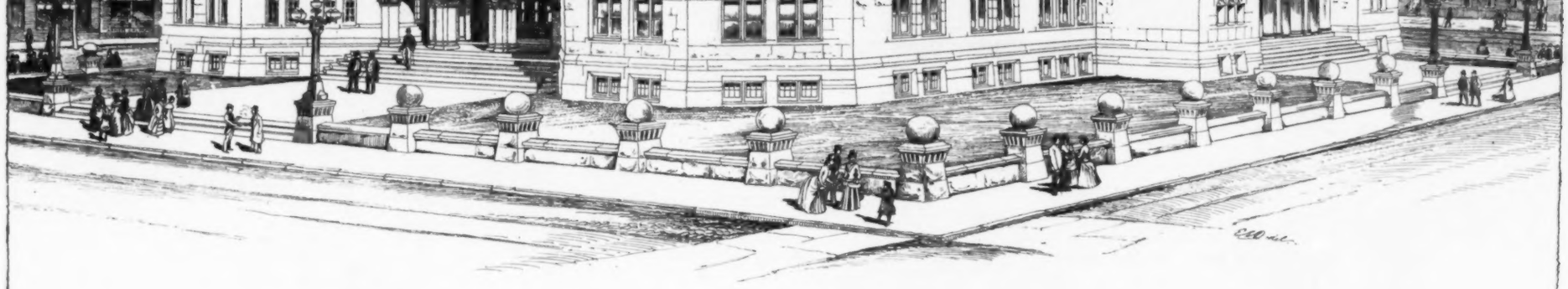
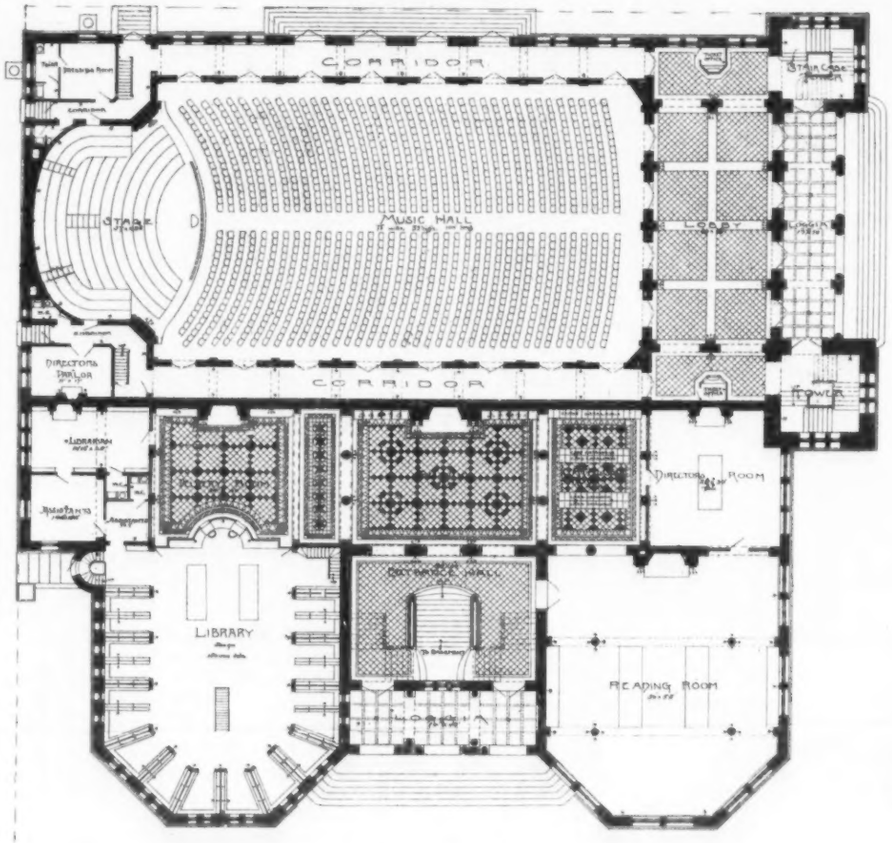
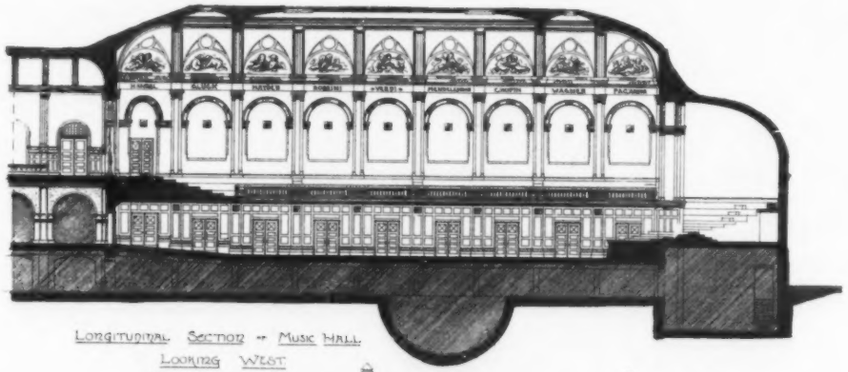


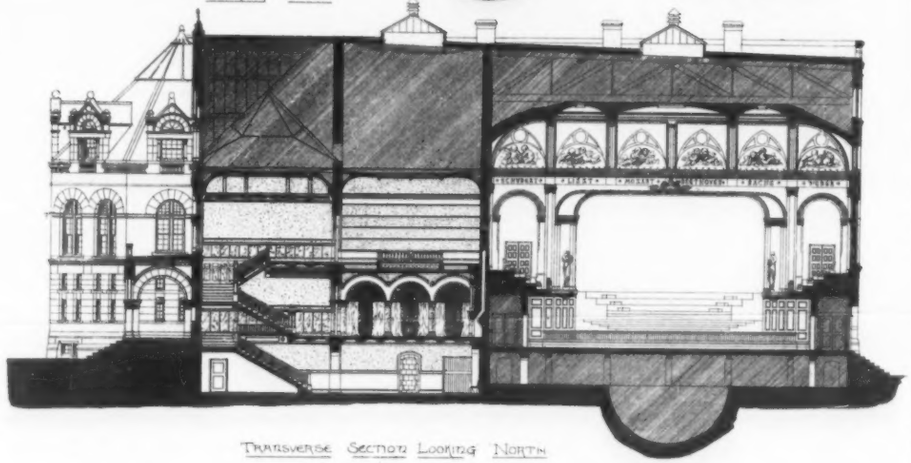




PLAN OF FIRST STORY



LONGITUDINAL SECTION OF MUSIC HALL LOOKING WEST



TRANSVERSE SECTION LOOKING NORTH

Heliotype Printing Co. Boston.

No. 557 AMERIGAN ARCHITECT AND BUILDING NEWS, MAR. 26 1887.

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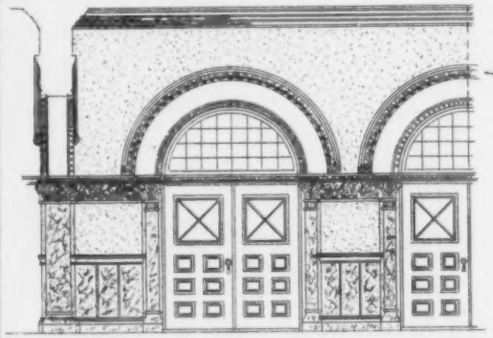
ELEVATION OF ENTRANCE FROM ENTRANCE HALL.



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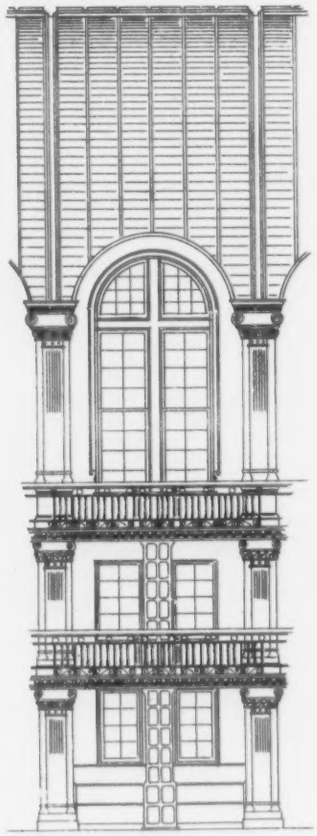
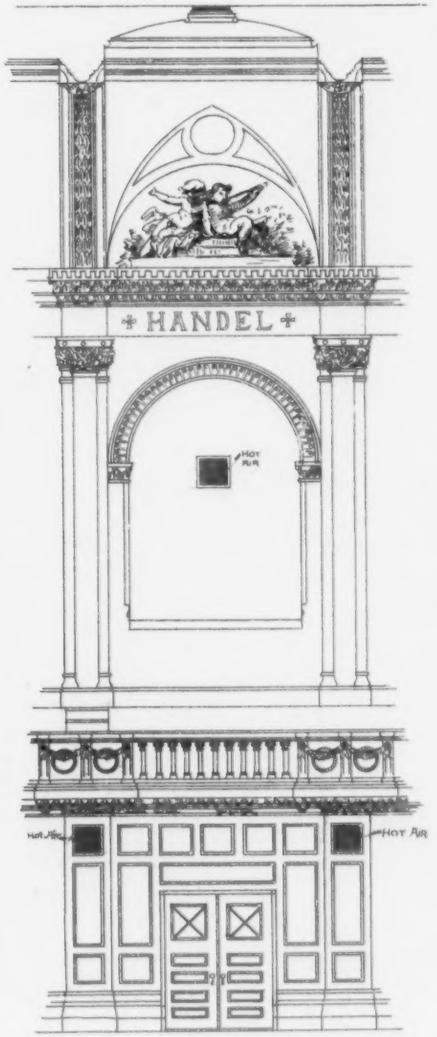
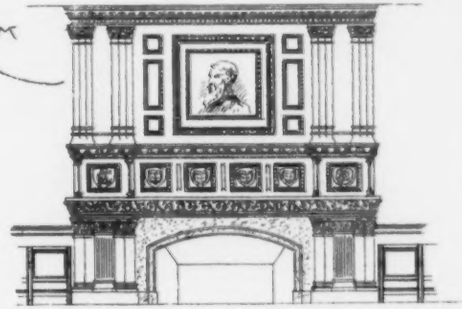


ELEVATION OF BAY IN BOOK ROOM



ELEVATION OF BAY IN MUSIC HALL

MANTEL IN PUBLIC ROOM



Suggestion for Stained Glass windows in the Carnegie Library.

Heliotype Printing Co. Boston.

American Antiquities and Paleolithic Man 03/13/87

Mercery · Lane. · Canterbury · Eng. C·J·Watson·

AMERICAN ARCHITECT AND BUILDING NEWS, MAR 26 1887. No. 587

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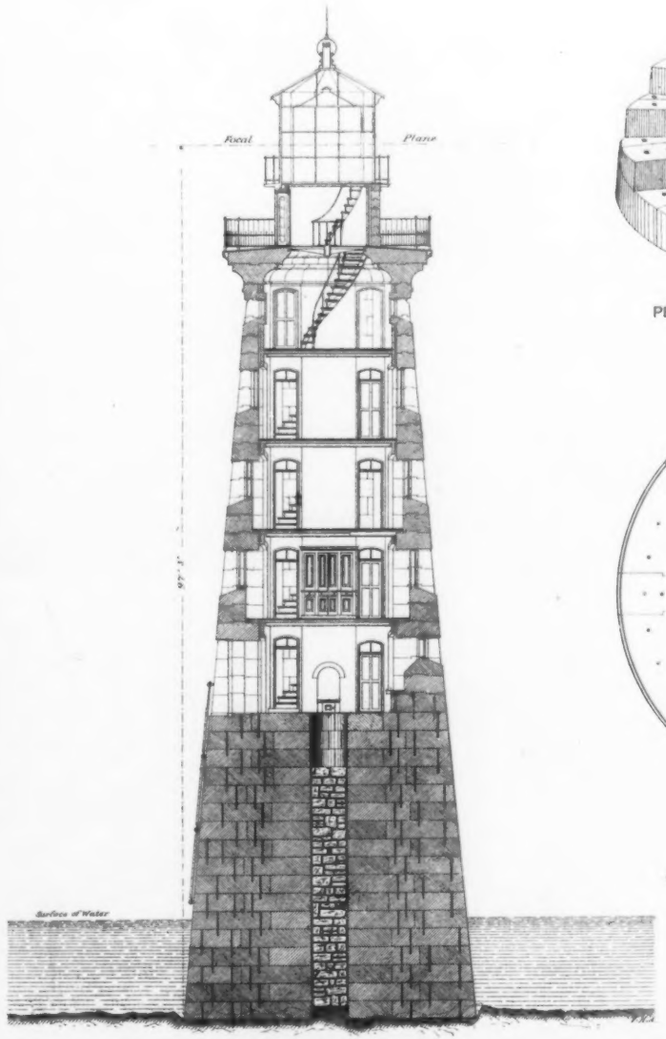
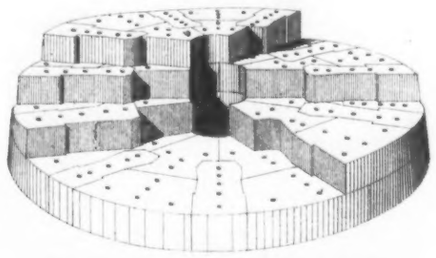
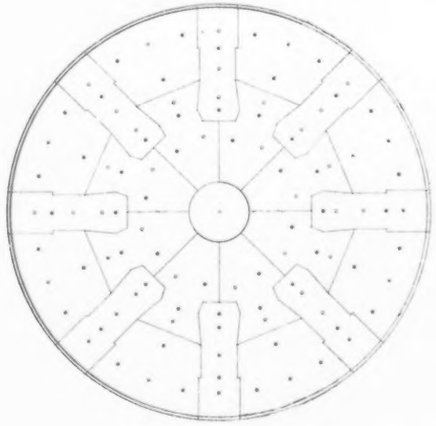


SECTION.
Scale in feet



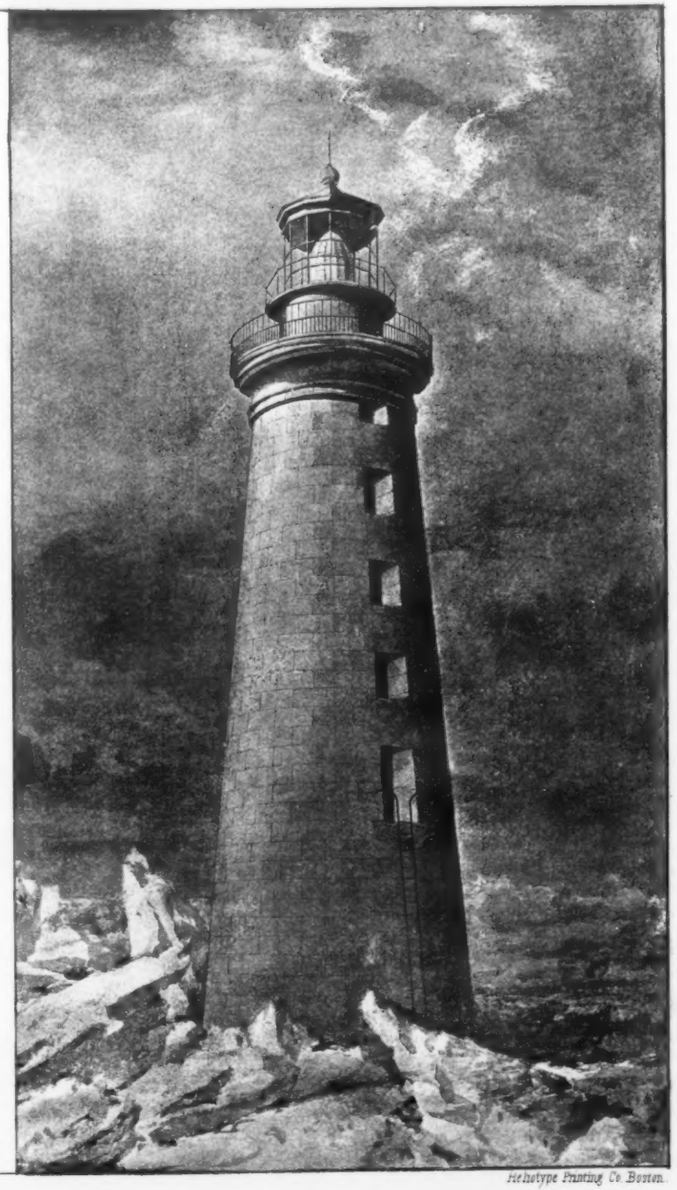
PERSPECTIVE VIEW OF COURSES 14, 15 & 16.



GROUND PLAN OF COURSE 14.

Scale

LIGHT-HOUSE AT SPECTACLE REEF,
LAKE HURON.



Heliotype Printing Co. Boston.

are ever, after the first disruption, lines of weakness, where the resistance to lateral pressure is diminished, and where the strain of large unbroken areas is relieved from time to time by displacements, necessarily attended by earthquakes. I have sometimes compared them to hinges on which the great tables of the earth's crust turn with constantly changing angles. Generally mountain chains may be said to grow by the constant or paroxysmal elevation of their arches, the increase in the throw of their faults. This growth would be much more apparent than it is if it were not that the mountain chains receive a far greater precipitation of moisture than the lowlands, and erosion, which is the opposing force to elevation, counteracts its effects. The East Indian geologists estimate that in the Himalayas the process of elevation is going on constantly and that it is at least equal to the loss by denudation. . . .

It will be noticed that, in the reports which have been given of the Charleston earthquake, there is an absence of all reference to the explosions which have been among the most striking and destructive phenomena of earthquake action in some localities. Thus in the description of the great earthquake of Riobamba, Equador, in which 40,000 persons perished, it is said that the bodies of many of the inhabitants were thrown upon a hill which rose to the height of 100 feet on the other side of a stream; and, during the earthquake of Chili, in 1837, a mast, planted 30 feet deep, was thrown out so that a round hole remained behind. These, which are called explosive earthquakes, have been confined to the vicinity of volcanoes and to districts bordering on the sea, and it is supposed that, by the disruption of the rocks, large quantities of water have been suddenly brought into contact with melted lava. Steam has played an important part in most volcanic eruptions, though, as a secondary, and not, as often supposed, a primary cause. Masses of molten matter, welling up through fissures in the earth's crust, must necessarily come in contact with subterranean reservoirs of water, or with strata saturated with moisture. In the vicinity of the sea, too, where most volcanoes are located, water may be admitted in the manner just described. In all these cases, steam would be generated in such quantities as to make this an efficient adjuvant to the lava flood in producing disruption, upheaval, and vibrations of the rocks. The absence of these violent features in the earthquakes of the country bordering the Alleghany belt, proves that volcanic action has had nothing to do with them, and shows that, like a vast majority of earthquakes elsewhere, these have been, as Dana says, "incidental phenomena in the process of mountain building"; that is, they are sensible signs of the lateral movement of the earth's crust, which results in the crushing, folding, faulting, elevation and metamorphism which are distinctive features of all mountain belts and chains. . . .

As is mentioned in the early part of this article, the first result of the discovery of the law of increase of temperature in going toward the centre of the earth, was the conclusion that the solid crust was not more than fifty miles in thickness, and below that was a sea of fluid or semi-fluid molten matter. Then mountain chains were supposed to be the result of the crushing together of solid sheets of rock as they followed the cooling and shrinking interior. The coat becoming too large, and adhering to the body, must wrinkle as the body shrank. Volcanic eruptions were supposed to be the oozing out of molten matter from the not distant zone of fused material, and all was harmonious in the geological world. Then came Professor Hopkins, Archdeacon Pratt, and Sir William Thompson, in the character of disturbers of the public peace; they said that the crust would be broken up by tides if it was as thin as supposed; that the shell would be pulled about on the fluid nucleus by the attraction of the moon on the equatorial protuberance; and, finally, that the tenacity with which the figure of the earth was maintained under the varying pull of the sun and moon made it necessary to suppose that it was, as a whole, as rigid as a globe of glass, or even of steel. Sir William Thompson conceded, with some hesitation, that the crust of the earth might not be more than 2500 miles in thickness; further than that, he would not go. Since that time, awed by his great and well-deserved fame, geologists have generally accepted the conditions he imposed upon them, and there has been a terrible struggle to reconcile volcanoes, earthquakes and the flexibility of the earth's crust with a solid interior. Some have gone back to Sir Humphrey Davy's theory, that volcanoes were the product of intense chemical action in certain circumscribed portions of the earth's mass; and others have supposed that, between a thick external crust and a solid interior there was an intermediate zone of fused matter from which volcanic ejections emanated. . . .

There would have been no question of the truth of the old theory of vulcanism if it had not been raised by the physicists whose names have been mentioned, and it can now be seen that their objections have little force. Delaunay, of Paris, and Hennessy, of Dublin, have shown that the premises assumed by Thompson, Hopkins and Pratt, in their attempted refutation of the old theory of a comparatively thin crust, are not those of nature, and that their conclusions are, as a consequence, irrelevant and valueless. Their objections were aimed at an incompressible fluid interior and an elastic crust; conditions which do not and could not exist. Besides this there must be a viscous zone of considerable thickness, in which the transition from the solid crust to the liquid interior is very gradual; and it is highly probable that the matter of this viscous zone is not only not itself affected by tidal movements, but that it acts as a buffer between the liquid interior and the solid crust. It should be remembered that the moon's attraction — the chief motor in oceanic tides — is a force applied to a surface moving at the equator about a thousand miles an hour. Even a fluid as thin as water refuses to obey instantly an attracting body. The tidal wave of the ocean is always considerably behind the moon, and in some places, where obstructed by topographical features, it does not reach its destination until some time the next day. It is easy to see that in a tarry, pitchy mass, the response to the moon's attraction would be far less prompt, and also that the tidal waves in zones of different depths and densities would not coincide, and might completely neutralize each other. . . .

The resistance which the internal friction of a viscous body would offer to a force applied with such velocity would be enormously greater. Hence we must conclude that the tidal movement in such a mass, even at the earth's surface, must be very small, and if, as is the case in the interior of the earth, that mass were condensed and constrained by the weight of a crust even a hundred miles in thickness, it would be inappreciable. . . .

It is difficult to imagine how the advocates of the theory of a solid globe can account for the formation of mountain chains, the loftiest and longest of which are quite modern, and it is not perhaps too much to say that these themselves are a refutation of their theory. It is evident that a heated solid globe, as it lost its heat, would either contract bodily, as a red-hot cannon-ball does, or by the more rapid cooling of the outer surface, that would shrink faster than the interior and crack in every direction; a process just the opposite from that which we find recorded in the earth's crust.

But there are other evidences of the flexibility of the earth's crust, which are incompatible with the theory which ascribes to it great thickness. (1) The lines of volcanoes which crown most great mountain chains are located along fissures which seem to be continuous for thousands of miles, and there is apparently good evidence that these fissures penetrate through the entire thickness of the solid

crust. Sometimes the volcanoes are in simultaneous action for several hundreds of miles, and the materials ejected, though showing much variety, are often identical; facts incomprehensible on any other supposition than that they have been drawn from a common reservoir.[1]

(2) Along all the coast lines the evidences of local changes of level now in progress, or included in the records of past time, are so numerous and striking, that the term terra-firma seems singularly ill-chosen; for example, the shores of the Mediterranean abound in evidences of local depressions or elevation, or both, since it has been occupied by civilized man. Of these the temple of Jupiter Serapis, at Baiæ, is one of the most famous, but by no means the only example.

On our own continent the southern portion of Greenland has been gradually sinking for several hundred years. Labrador and Newfoundland are rising; Prince Edward's Island and Cape Breton, according to Gesner, have sunk many feet since they were first occupied by the whites. In Nova Scotia the land is rising; in Northern Maine it is sinking, as also at Cape Cod and Martha's Vineyard, and on the shore of Long Island and New Jersey. Here the subsidence has locally varied from two to twelve feet during the last century. In the West Indies there are many evidences of local change of level; in some cases, of elevation; others of subsidence. In California we find traces of recent and local flexures of the coast which are very striking; at San Diego is an old beach strewed with shells which have not yet lost their colors, twenty feet above the present sea-level. At San Pedro, the port of Los Angeles, the limestone rocks which form the sea cliffs are bored by pholas eighty feet above the water; on the south shore of San Pablo Bay, at a height of twenty feet above the water, is a bank of oyster-shells, four feet in thickness; this descends toward the south, and disappears beneath the surface of San Francisco Bay. Puget Sound, with its many branches, is only the submerged valley of a great river which ran out to sea through the Straits of Fuca when the coast was much higher than now; but the shores are terraced to the height of 1,600 feet above the present water-level; showing that, in recent times, they have been much lower than now. Similar facts with these have been reported from the shores of all the continents, and the islands afford more striking examples of the changes of level; the Windward Islands are only the summits of a lofty mountain chain which was once all above the sea-level, as is shown by the community of species in animals and plants. The Islands of the South Pacific are also the summits of mountains which have been gradually submerged, as has been shown by Dana and Darwin. Coral reefs, which are formed only within 150 feet of the surface, now extend down in continuous walls, 2,000 feet below the water; the growth of the coral having kept pace with the gradual subsidence. Elisé Reclus, in "*La Terre*," and Professor Prestwich, in his "*Geology*," give maps showing the fluctuations of level now in progress along coast lines, and whoever will examine these maps will find it difficult to reconcile these oscillations of the land with a globe solid to its centre, or even with a thick crust. But the changes of level now taking place proceed so slowly that the record of one hundred and fifty years, during which geological observations have been made, or even that of the long period covered by human history, is insignificant, compared with that of the geological ages. Indeed, historical geology is, for the most part, but a transcript from the monuments left by successive and local subsidences of the land, influxes of the sea, and the deposition of strata containing relics of the marine and terrestrial life of the epochs in which these inundations occurred. Scarce any portion of any continent is without traces of the presence of the sea, and, while some of these submergences were doubtless caused by great tides, which ebbed and flowed from one hemisphere into the other, in the manner suggested by Adhémar, it can be easily shown that most of them were occasioned by local subsidences of the land.

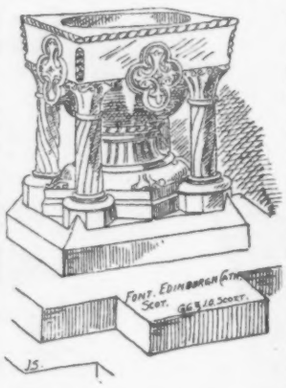
All these lines of evidences, furnished by earthquakes, mountain chains, volcanoes and terrestrial oscillations, converge to one point, and, in combination, go far to prove that the earth's crust is relatively thin, and that its interior is fluid or viscous. . . .

If it is true, as claimed on the preceding pages, that earthquakes are the vibrations attending the folding and breaking of rocks which have been in a state of strain, it is evident that the provoking cause of any special paroxysm might be a comparatively trifling affair — some feather that should break the camel's back. Thus, we have reason to believe that atmospheric conditions may precipitate these catastrophes. The pressure of the atmosphere on the earth's surface is 14.7 pounds to the square inch — that is, a little over 2,000 pounds to the square foot, or about 30,000,000 tons to the square mile. Now it sometimes happens that the mercury oscillates two inches in the tube of a barometer in connection with some violent storm; and it is true that the areas of low and high pressure change position quite rapidly. Hence, if it should happen that the underlying rocks were, from lateral pressure, in a state of strain that had nearly reached the limit of resistance, a change of atmospheric pressure equivalent to two, or even one inch of mercury (equal to 1,000,000 or 2,000,000 tons per mile) might be the cause of a rupture. So, the popular belief, that peculiar atmospheric conditions have had an influence in causing earthquakes, is not so absurd as it might seem.

Another cause which has certainly operated to disturb the static equilibrium of the earth's crust, is the transfer of the products of erosion from the land to the bottom of an adjacent sea-basin. Over all land areas where the rainfall is considerable, there is a constant wearing away of the surface by chemical and mechanical agents. About one-fourth of the material removed is dissolved, and may be carried to the opposite side of the earth before it is precipitated; but the other three-fourths, in the form of gravel, sand and clay, are simply held in suspension by running waters, and are deposited as soon as their motion is arrested. Rivers, rivulets and shore-waves are constantly engaged in transporting material from the land to the deeper water bordering the coasts; there spreading it, to make new series of sedimentary deposits. As these accumulate, they not only impose new burdens on the underlying rocks, but by acting as a blanket and preventing the escape of heat, they promote the softening and weakening of a belt of sea bottom. This process has produced great changes in the surface topography of many continents, and it is credited with the formation of a number of littoral mountain chains. The blanketed belt of off-shore sea-bottom, softened by heat, yields to lateral pressure and is forced up in a series of faults and folds. There is little doubt that the loading of the sea-bottom with the products of erosion has been one cause of the earthquake vibrations which have been so frequent along our Atlantic coast.

[1] Darwin mentions (Trans. Geol. Soc., March, 1838), that in the Andes the volcanoes Osorno, in lat. 48° S., Concagua, in 32° S., and Coseguina, in lat. 13° N., burst into eruption simultaneously on the 20th of January, 1835. The more remote of the three are 3,700 miles apart.

UTILIZATION OF TOWN SEWAGE BY IRRIGATION.[2]—III.



WE now come to the hygienic aspect of sewage-farming, which is classed under three heads. I dealt with some of these objections so fully, when the subject was discussed by the Society after the reading of Dr. Tidy's paper, that I may refer my hearers to the report which is published in *Journal* No. 1776, that of December 3d of last year. I will not weary you by reiterating what I then advanced. I must, however, make reference to the action of the Lunacy Commissioners. Some twenty-three years ago, an attack of dysentery arose in the Cumberland and Westmoreland Asylum, of which the resident medical officer thought it possible for the sewage-farm to have been the cause. "The facts show," says Dr. Tidy, "that sewage emanations from sewage-farms may be the cause of dysentery, diarrhœa, and typhoid fever." I beg leave to differ *in toto* from Dr. Tidy upon this point; the facts showed nothing of the kind, except the notion of *post hoc, ergo propter hoc*. There was not a single point which really proved the sequence as cause and effect. And although sewage utilization by means of irrigation, sometimes in most insanitary and objectionable ways, as far as the senses are concerned, has been practised in hundreds of places all over the kingdom, no such alliance has ever been proved to exist, and no such result has been satisfactorily brought to the notice of any Court of Law, or to that of the Local Government Board at Whitehall. For this opinion I have the authority of Mr. Arnold Taylor, who supported the statement when I made it before him last year, when he was holding an official inquiry at Croydon, as to an extension of the Norwood farm.

In 1884, the Commissioners in Lunacy issued instructions to the managers of lunatic asylums, "As practical suggestions to those authorities in reference to sewerage, drainage, water-supply and sewage irrigation." There are no other directions as to disposal of sewage except by irrigation, in which the Commissioners, following the advice of a very deservedly distinguished engineer, Sir Robert Rawlinson, have dwelt with the subject on a practical as well as scientific basis. I commend the directions in those instructions to the attention of those interested in the welfare of the country, and would suggest that at any rate the Lunacy Commissioners have no belief in Dr. Tidy's theory that sewage emanations from sewage-farms cause dysentery, diarrhœa and typhoid fever, and they have abundant evidence to rely upon.

Nearly all the lunatic asylums and other establishments for large masses of people which have been built in recent years, such as Sir Richard Cross's asylums for the imbecile, utilize their sewage in the manner indicated by the Lunacy Commissioners; in some cases using the liquid matter in close proximity to their airing grounds without a single proof of mischief from the result. It would be interesting to collect (if time would allow of it) the extracts from the reports of the managers of these institutions to their constituents at Quarter Sessions in different parts of the country, in which it is universally stated that the results are "highly satisfactory." Why Dr. Tidy should ignore this evidence and rest his case upon the shadowy opinions of the *post hoc, ergo propter hoc*, passes my comprehension. I have a return before me from Catherham asylum, which has 2,000 inmates. The report states "that they have no permanent pasture;

[2] A paper read before the Society of Arts by Alfred Carpenter, M. D., M. R. C. P., London, and published in the *Journal of the Society of Arts*. Continued from page 140, No. 586.

that 126 acres are cultivated as arable land, or laid down in rye grass as required. The rye grass plots allow of recreation for the patients when such is needed."

Dr. Tidy likens sewage-farms to the fens of Lincolnshire and the rice fields of China. The mischief arising in fenny districts is caused by stagnation; it is capable of removal in the larger part; nay, it is removed. The fens are the same districts now as they were before the stagnant water was removed; dysentery is almost unknown there. They have the same contingencies minus stagnation, and they are as healthy, if they are drained, as any other parts of the kingdom. If there is stagnation upon a sewage-farm there is no financial result, and then there might be such conditions as is described, but such a state is no part of sewage-farm cultivation. Dr. Tidy sums up his denunciations of sewage-farming, on page 1150 of our *Journal*, in a series of charges, most of which counteract each other. As, for instance, that "an untrained observer," such are his words, can easily form a conclusion "that conditions vary;" surely every agriculturist knows that, and knows also that he must prepare his land accordingly. "Inequality of purification," "uncertainty of action," must be met by alteration of arrangement. If there is heavy rain, you must increase your area under sewage for the time being, or arrange to exclude the rainfall. It must be passed over a double set of plots, one after the other. The first being rye grass, or possibly arable, the second may be meadow. None of the conditions described by Dr. Tidy are parts of good sewage-farming; his ague, his dysentery, and his diarrhœa, exist only in his active brain, for there is not a particle of reliable evidence to connect them even with sewage-farm mismanagement, let alone the correct way of dealing with the matter.

The remark as to the pollution of the subsoil water, which is possible, is also as pertinent as that which might be applied to railway management. If they do not exercise proper care, life will be lost; but the law requires proper care, and the loss of life is almost *nil*.

Let me now refer to the remarks upon the distribution of the ova of the entozoa by sewage-farms. I mentioned my correspondence with Dr. Cobbold on the occasion when I addressed the Society in the discussion upon Dr. Tidy's paper. The occasion arose in this way. I wrote to him, inviting him to a breakfast upon the farm upon sewage-grown produce in 1875. A family bereavement at that time prevented Dr. Cobbold's acceptance of my invitation. In his reply, he says, "I have been obliged to put a check, and to modify my views, upon the subject of sewage, which I formerly displayed, on purely scientific grounds."

Some time after that, a herd of beasts which had been fed for two years upon sewage produce on the sewage-farm were in process of slaughtering by a carcass butcher, and I invited Dr. Cobbold to witness the process, and inspect for himself the bodies of the animals as they were killed, as well as those which had been cut up for two days. He was not well, and excused himself from making the inspection, stating at the same time that he had modified his opinions, and become quite convinced that the view he had held, as to the possible propagation of tapeworm eggs, and the distribution of hydatids, or of the cysticerci, were not likely to arise in beasts fed on sewage produce. I have never seen hydatids in animals fed at Beddington. I believe they are not found at Birmingham. Thousands of animals have been fed upon these two farms, and used as food, and it would have been impossible for the existence of such a result to have escaped the observation of the lynx-eyed observers who are always at hand to decry the results of sewage-farming. I do not deny the possibility of such a result, but I think it highly improbable, because the conditions under which the ova of human parasites continue to be propagated, do not hold in the method under which sewage ought to be distributed. If Dr. Tidy could produce an animal infected as he suggests, it would not be an argument against sewage-farming, but it would be grounds for serious charges against the managers of the farm upon which it took place, in allowing cattle to go upon recently sewaged areas. It is impossible to suppose that the ova of creatures which only propagate themselves in the human juices, and at a temperature of 98.5, could retain their vitality in the sewage, and upon the soil for a fortnight under the circumstances of a deprivation of moisture and exposure to light and air that must happen to them if distributed by broad irrigation. I believe the ova presented to the radicles of rye grass are as efficiently digested by that plant as the little fly is by the *Dionea muscipula*, or the ova of the dead frog by the amœba in the wayside ditch, or the particle of meat which may be caught by the tentacles of the sea anemone in a seaside pool.

Dr. Tidy says, that as regards the disease produced by the *Trichina spiralis* "no doubt the danger is constant, but sewage irrigation would render it an affair of certainty." How Dr. Tidy could pen such a baseless statement passes my comprehension, for the produce of more than one hundred irrigated areas are utilized as food at this moment. I have never met with a case connected in any way with sewage-farming, and I ask Dr. Tidy to produce the series which ought to be forthcoming in support of such a statement.

Dr. Tidy's conclusions that to achieve commercial success you must abandon sanitary considerations, are shown by my proofs to be utterly untenable. I contend that financial or commercial success can only follow when sanitary considerations are strictly attended to. Financial loss goes with non-attention both to letter and spirit of sanitary law.

Let sanitary law be looked after, let the local authority do its duty in dismissing sewage as rapidly as possible from within the borders of the town, so that all such may be on the farm within six hours. Let the authority keep out from the sewers the rainfall, except such as falls upon paved streets, courts and alleys. Let them provide the land which is required for the purpose, and not only will the sanitary result be highly satisfactory, but the financial result will be satisfactory too. I do not mean to assert that a sewage-farm can meet the engineering charges which may be necessary to get the sewage upon the land; I do not mean to assert that a sewage-farm can pay a rent sufficient to cover interest and principal when so-called building-ground has to be taken for the purpose. Such charges must be borne by the locality providing the sewage. There is, however, this certainty about it, that the dearer the land which is taken, the greater and the denser will be the population for which it has to be provided. The higher the rateable value of the district, the more able will it be to bear the consequent charges, which in no case, if common honesty and common sense be used, ever need be more than a quarterly rate of 1*d*. in the £, or 2*d*. per half year. This is about the rate which towns may have to pay to have their sewage utilized, and themselves freed from its evil consequences, if it be retained in their midst. In addition to this charge, they must also pay the requisite engineering charges for the production of sewers, which shall not be sewers of deposit, or deliver stinking sewage at their outfall. The denser the population, and the higher the value of land, the greater will be the demand for milk, cabbages, and meat in that locality, and the more certain the market, therefore, for the produce raised on the farm. Whilst as to the fund sunk in the production of the works, it will not be lost, but will be a fund which will be the evidence of wealth among the people who advance the money, of a much more satisfactory character than is the wealth which the French people possess in consequence of the occupation of Paris by the Prussians in the last war, and no place would be more enriched by such a proceeding than the great metropolis itself.

It may be pertinently asked, if the conclusions I have arrived at are so satisfactory, why does not sewage-farming become more general. Let me give you the experience of the Borough of Blackburn. The corporation of the borough triumphed over immense engineering difficulties, and obtained the land required for the purpose. They could not agree with the owner; they took it, therefore, by arbitration, though it was only agricultural land in its strict sense, 380 acres of land, bringing in at most £580 a year. They were compelled to pay seventy-nine years' purchase for that land, whilst the cost of the arbitration amounted to the enormous sum of £13,500. This result was enough to frighten any corporation from attempting to obtain land for such purposes again, and since that time very few attempts have been made to do so. A greater legal robbery was never perpetrated, or a more obvious case of people being made to pay through the nose for what they had a perfect right to take at a fair agricultural value. Sewage-farming is very heavily handicapped; it is opposed by many of the chemists who find it to their interest to support a chemical side of the question; it is opposed by all interested in companies for the sale of patent manures, and of those interested in the speculation which belongs to shares; it is opposed by all who are likely to get promotion-money for other schemes, or to be called as witnesses by parties interested in raising the value of the land proposed to be taken. It has no supporters except those who follow sanitary work for the sanitary work's sake. The Blackburn corporation are, however, deserving of the greatest praise; They have 510 acres of land, for some of which the arbitrator made them pay far beyond the amount claimed even by the owner. In some of it there is a difference of 200 feet in the level. Their engineering and financial difficulties were immense, but taking their two farms together, there is a gain of £300 a year. With such a result before a corporation or a local board, and the difficulty which the Upper Thames Valley authorities found in their efforts to get land, it is not surprising that they hesitate to commit themselves to sewage-farming, but continue to flounder about in chemical-works and precipitation-schemes. The law as to the powers of a local authority to take possession of land for public purposes requires to be seriously altered before it is likely that such schemes will be promoted by corporations, unless by agreement as to price with the land owner.

As I have mentioned, in the years 1876 and 1877 the Society of Arts organized a series of meetings to discuss the sewage question. At both those meetings reports were presented as to the custom followed in all the large towns of the kingdom. In thirty-eight cases the sewage had been, or was about to be dealt with by means of irrigation. I have written to the authorities in all those towns, asking them to give me a few lines upon the present state of the case; whether irrigation is still practised, and with what success, and if not, why not? Appended are the answers I have received from thirty-four of those towns, and I return my thanks to the town-clerks and engineers who so kindly responded to my application.

In thirty out of thirty-eight the answer is a decisively satisfactory one; in six there is no reply, though I know personally that in four the process is satisfactorily continued. No injunctions have been suggested except in one case (Kidderminster) in which damages are claimed. In one small place (Hoole) the sewage now goes into the Chester sewers, and in another (Oswestry) irrigation has been discontinued, because the site was inapplicable for the purpose. There is no hesitation as to the result sanitarily, though nearly all deplore the fall of agricultural prices, and fail to obtain the financial result

which they had anticipated. The reasons for this are manifest either in the nature of the works, the surcharge with expenses they ought not to bear, or the gigantic faults made in the original conception of the scheme. But the broad fact is still patent that sewage can produce a certain result if it be dealt with properly, and no town is justified in allowing that 5*s.* per head to be recklessly destroyed, when, by reason of Continental contingencies, it might make all the difference between famine and surrender to our national enemies, or to a triumphant result in a terrible contest.

Report upon present practice of Sewage Utilization in those towns in which Sewage Irrigation was practised in the year 1877, as then reported to the Society of Arts; in alphabetical order.

Aberdeen, 1876.—Forty-four acres of land irrigated for the past six years with good results.—Mr. Goodall, the town clerk, now reports that the system is still in operation; it is only for the third part of the city, and only during a portion of the year, just as in 1876. He is informed that the effluent water is comparatively pure.

Banbury, 1876.—Sewage pumped to farm of 138 acres.—Mr. T. Pain, clerk to the Local Board, writes "Irrigation is still followed, the system is found to be very satisfactory; there is no complaint, either with regard to the character of the effluent, nor of any nuisance arising from smell."

Bedford, 1876.—Sewage pumped to 10 acres of land.—Mr. J. H. Collet writes: "The system is still carried on with great success, as far as the sewage is concerned, but by reason of excessive rents, and the low price of produce, it is not paying at the present time; we see very little of the effluent, having very few acres of the land underdrained. Our sewage is passed through the soil, which is of a very porous character."

Blackburn, 1876.—Irrigation practised for three years.—Mr. Squire, the town clerk, writes that the Corporation have about 400 acres under irrigation, and that the process is commercially successful. The facts mentioned in the text of my paper are taken from an excellent *résumé* of the works prepared by Mr. J. B. KeCallum, the Borough engineer, which shows what skill can effect.

Birmingham, 1876.—Twelve million gallons daily treated with lime at Saltley, and the sewage then utilized upon land by irrigation.—Mr. W. S. Till, engineer to the Board, states, in a recently published paper, that the necessity for lime treatment arises from the nature of the manufacturers of Birmingham. That they have 1,227 acres available for sewage disposal. That 16,000,000 gallons are daily utilized on the farm. The Corporation realized £4,406 last year by the sale of milk. The income for the sale of stock and plant was £22,728; whilst the payments which included rates, taxes, and purchase of stock (£7,760), amounted to £22,822. I visited this farm last year and was conducted over it by Alderman Avory. The condition of the stock was everything that could be desired as to health and nutrition; there was an entire absence of any of those conditions suggested by Dr. Tidy. The manner in which it is worked as a milk-producing farm is highly creditable to the managers. But there are cultivations which do not belong to a sewage-farm. It is worthy of imitation, as showing what may be done in stock-keeping and milk-producing. Only 100 acres are laid down with rye grass. There can be no doubt as to the satisfactory character of the effluent, and also the absence of nuisance from the farm itself, though the quality of sludge is something enormous.

Cheltenham, 1876.—Irrigation on grass land carried on for about ten years.—Mr. Bridge, the town clerk, writes: "Since the date of last report to the Society of Arts, we have purchased 230 acres of land three miles out of the town. The effluent is fairly clear, and we have no complaints. At one of the farms it is passed through some filter-beds before being passed into the stream. We let the farms, and we sell dressings of the fluid sewage to the farms on the line of outfall sewers. The income is about £1,000 a year. We have not completed one of the farms, but when the whole is let we expect to increase the rental. The outlay, including management, interest, and repayment of loan, amounts to about £2,200 a year. A penny in the £ produces £900, consequently the net cost of the disposal of our sewage is about 1*kd.* in the £ on the rateable value, this, it being understood, includes interest on the purchase-money of the farms, which cost us £22,000, and the annual repayment of principal."

Chorley, 1876.—Five hundred thousand gallons per day utilized on sewage-farm, but report says pail-system found (?) best in this locality in respect of cleanliness and utilization.—Mr. Jackson, the town clerk, now writes: "We have still a sewage-farm for the utilization of sewage, which is, upon the whole, from a sanitary point of view, quite satisfactory, but the subsoil of the land is clay, and the effluent not so pure as it would otherwise be. Pecuniarily, the farm is not a success, the loss annually being about £200 or £300 a year. This is attributable, perhaps, here rather to local causes than to the faults of the system."

Croydon, 1876.—Irrigation for the past sixteen years. Net cost in 1875 equal to 1½*d.* in the £ rate, including rental of 360 acres of land at £10 an acre.—Now (1887) the corporation have more than 700 acres of land which are used for irrigation. It has been purchased at an average cost of more than £300 an acre, and since the purchase a great expenditure has been incurred in building cottages for workmen, and erecting proper farm buildings, so that the old system of starving the farm need not be continued. It had been the custom to avoid the purchase of stock; to pay into current account the sums received for the sale of that which was on the farm, so as to reduce current rate, but not to provide for the consumption of the produce next year. The result was, as I have stated in my paper, the destruction of more than 200 acres of rye-grass land, whilst new fields were not prepared. In 1877 and 1878 the receipts from produce were £7,162 and £7,585 respectively, but in 1880 it sank to £4,088 and in 1881 to £3,891, entirely from mismanagement by irresponsible farm committees, who declined to continue the plan of producing milk and using up produce by their own stock. The receipts from sale of milk dropped from £2,320 to £819. At this juncture a wise and far-sighted milk farmer erected cow-houses for 300 cows upon a part of the farm at Beddington, and entered into an agreement with the Corporation for the supply of grass, and raised the income to the Corporation, for the sale of grass, to the figure it had occupied in 1879, viz., £2,300. The proprietor of those cow-sheds has, at this moment, one of the finest herds of cattle to be found in any part of the country, producing an abundance of rich milk which has a very ready sale, and his cattle will (like those at Birmingham) be able to hold their own for weight, personal appearance, sleekness, with any herd in the kingdom, for they are carefully groomed and kept, as cattle ought to be, as clean as a stud of horses. He is doing what the Croydon Corporation were unable to do, to the great advantage of the neighborhood, and I have not the least doubt also, to his own pecuniary benefit. I wish him most perfect success. The income from the farm, during the year ending Lady-day, 1886, amounted to £9,181: the expenditure to £5,101. I am unable to say how the valuation of the live and dead stock upon the farm stands, as it is not included in the published accounts, but I have reason to believe that it is increased and not diminished. I would, however, remark that it is utterly impossible to farm a large property, like that which is in the hands of the Corporation, unless there is stock upon the land to utilize the produce, and 700 acres ought to have a valuation of at least £14,000, to do justice to the work which has to be done. The larger the stock with which the managers have to work, the better the chance of a good pecuniary result. This is seen in the fact that, whereas the farm ought and could, with proper management, now produce £15,000 a year, there has been only obtained £9,000. The working-expenses have, however, been all met, and £4,000 forthcoming towards the payment of interest and principal upon the purchase money; and somewhat less than a 2*d.* rate enables the locality to deal with its sewage without fouling the rivers of the district. As regards its sanitary effect upon the locality, in 1881 I read a paper before the International Medical Congress in London, based upon the experiences of the Croydon sewage-farm. The nine propositions which I then submitted, and which are embodied in their "Transactions," have never been controverted. I will now add the vital statistics of the parish of Beddington and the hamlet of Wallington, in which the farm is situated, and which takes up about one-seventh of its area.

Year.	Population.	Rateable value.
1861	1,557	£11,700
1871	2,874	20,671
1881	5,492	42,450
1886	6,000	46,520

The birth-rate has been gradually rising, and the death-rate gradually falling, during the whole of the time. From the above figures it will be seen that the proximity of a large sewage-farm has not prevented the steady increase in a given neighborhood. There has been steady increase in population, and rise in rateable value of the parish, from 1,557 persons and £11,700 rateable value when the farm was first started, to over 6,000 persons and a value of £46,520 in 1886. Where, then, is Dr. Tidy's idea of depreciated value, increased unhealthiness, and prevalence of diarrhœa, dysentery, and typhoid fever. Surely, land upon which sewage has been utilized by irrigation for more than thirty years, would show the effects, if it was injurious, upon the 6,000 well-to-do persons who have come within a mile of its borders since it has been established, the area of the farm taking up one-seventh of the whole parish. As regards the analyses of effluent-water which have been occasionally made, they have, as far as I know, always been sufficiently pure to go into the Thames, without the least chance of evil to the fish of the Wandle or the human beings on its borders. I am not advocating the theory that effluent is proper water to drink. I have always urged that it is not intended for that purpose, but it is safe where the effluent from certain precipitation processes is not. It contains excess of chlorine, and when applied too long to one plot, there will be an escape of some of the nitrogen. It is a fault of management, and not a fault of the system. Dr. Tidy does not deny the capacity of soil and vegetation to purify sewage; that which can be done by one or the other can always be done by both if a proper supervision is exercised.

Doncaster, 1877.—Sewage pumped upon farm three miles away.—Mr. Shirley, the town clerk, writes: "The borough possesses 263 acres, laid out, in 1873, by Mr. B. S. Brundell. It was leased in 1874 to the brother of the engineer, at an annual rent of £812. The lease expiring this 2d of February, the Corporation advertised for tenders, and finally let the farm at an annual rate of £550, with 15 acres of additional pasture, the then tenant only offering £500. The farm is about two miles from Doncaster, and we have never heard of the smallest complaint. We have a population of about 25,000 people."

Epsom, 1877. — About three-fourths of sewage dealt with by subsidence and irrigation upon 60 acres of land rented by the Board.

Windsor and Eton, 1876. — Sewage dealt with by irrigation on separate system. Has been in operation for six years on 50 acres. — Mr. Whitehouse, the surveyor, writes: "We have carried on the irrigation system with great success since 1870 to the present day. The town and college are drained upon the separate system, to the total exclusion of storm and surface water. There is no complaint from any one living near to the farm. The farm was laid out by the late Mr. Menzies."

Harrogate, 1876. — Irrigation in use seven years for portion of locality. — Mr. W. H. Wyles writes: "We have a sewage-farm of 310 acres, over which the sewage has flowed for a good many years, in some parts for nearly twenty. There is no pumping. The natural slopes offer easy gradients. The effluent passes into the brook sufficiently pure to satisfy keen and hostile observers. Our only practical difficulty arises from the nature of the soil. This is, then, with a clay subsoil which quickly hardens in winter, and cracks in summer, so that we have to exercise the greatest care. Still the results to us are, on the whole, satisfactory."

Hoole, 1876. — Irrigation for seven years past; population 1,720. — Mr. Weaver, the clerk to Local Board, writes that complaints were made against the filtering-tanks which the Local Board used before allowing the sewage to go on to the land in 1882, and since that time their sewage has gone into the Chester outfall sewer, and the practice discontinued.

Kendal, 1876. — Downward filtration and irrigation for portion of the sewage. — Mr. Bolton, the town clerk, writes: "Mr. Alderman Nilhson gives me notes. Downward intermittent filtration is carried on here with the same success which has attended it during the past ten years. We have about 9 acres of under-drained land, cropped in the following manner: 2½ acres rye grass, and 6½ acres producing a great variety of vegetables of good quality in about 5 feet ridges; carrots last year, over 14 tons to the acre. Some of the beds were afflicted with grub two years ago; we found that a dressing of gas-lime was a preventive. We have four acres of grass-land, over which we flow the sewage about four times a year. The remainder, about 8½ acres, is brought into a high state of cultivation by applying the sediment of the filtering-tanks, and lets at £5 per acre. The acres can be worked by two men and one horse, and the produce leaves a profit, after payment of the cost of working, of £60 a year. The effluent water of the outlet is always clear. The drawback is having too much subsoil-water, amounting to 1,000,000 gallons a day, to deal with."

Kidderminster, 1876. — Sewage dealt with by irrigation. — Mr. James Morton, the town clerk, writes: "Irrigation still carried on upon the corporation farm in the same manner as in 1876. The effluent is perfectly clear and without smell, as I can personally testify. Mr. Arthur Coomber, the borough engineer, says that the effluent is perfectly clear and in every way satisfactory. The farm is, at the present time, in a highly satisfactory condition. Mr. Morton, however, informs me that a neighboring owner is claiming damages for depreciation, which will have to be settled by an appeal to a law court."

Leamington, 1876. — Sewage used upon a farm belonging to the Earl of Warwick. — The town clerk now writes that irrigation is still carried out upon Lord Warwick's farm. During the last sixteen years I have never heard a complaint arising from the effluent water. The Corporation have just made a fresh arrangement with Lord Warwick for continuing the agreement, by which he receives the sewage for a further period of thirty years.

Leek, 1876. — Portion dealt with by irrigation. It has been found the best method of disposing of water-carried sewage; 450,000 gallons every twenty-four hours. — Mr. K. Farrow writes: "In 1860 a covenant was entered into with certain land owners to use the sewage by irrigation. All went well for many years, but some extensive silk dye-works and print-works were established, which added about 200,000 gallons of waste water to the sewage, that became so diluted as to be of little value for irrigation, and consequently the whole found its way into the river. The dyers have now constructed a separate sewer for the waste dye water, and the sewage is restored to its usual state. We shall now be able to go on satisfactorily again. No payment is made by the land-owners for the sewage."

Longton, 1876. — Sewage used by irrigation upon land belonging to the Duke of Sutherland. The Duke to pay £500 a year for it. — Mr. Hawley, the town clerk, writes: "I have no means of knowing what result the character of the effluent has been attained, but I have never heard of any complaint. The same contract exists as in 1876."

Malvern, 1876. — Intended to adopt the intermittent downward filtration scheme and irrigation proper, used for irrigation in 1877. — Mr. Jno. Palmer, the Town Surveyor, writes: "The system has been in operation since 1882, viz., broad irrigation and intermittent downward filtration. It is working satisfactorily, with a good effluent. The total area under cultivation is about thirty-five acres, eleven acres of which is under the intermittent filtration, and is divided into eleven sections, two and one-half acres of osiers, and the remainder broad irrigation. We have a farmstead; nearly the whole of the produce is consumed by the stock. There is a ready sale for the osiers, and all the crops during the past year have been excellent. We have separated the storm-water from the sewage, except that from the tops of houses and yards. If laid out with our present experience, we could materially improve the construction, and get a much higher standard of purity."

Norwich, 1876. — Sewage pumped to land 150 feet above, and 24 miles from the station. Irrigation has been in use for four years. Three million gallons every 24 hours. — Mr. Marshall, the city engineer, states that the farm has been successful in purifying the sewage, but as a commercial speculation it has not been so; the sewage is poor, but few water-closets in the city, and the sewage almost all spring rain-water. The farm is let out to a good tenant, who works it as a dairy-farm. We lose about £100 a year on the rent. I think it does fairly well.

Oxford, 1877. — Sewage will be utilized by irrigation, being pumped to a farm of 320 acres; is being laid out. — Mr. W. H. White, the engineer to the Oxford Local Board, writes: "Sewage was pumped to the land first in 1880. We get a satisfactory effluent, and there are no complaints of the farm from adjoining occupiers. Roughly, the financial result of our operations is that the produce of the farm rather more than pays the actual working expenses."

Reigate, 1876. — Sewage utilized on farm. — Dr. Grace, the Town Clerk, writes: "Utilization of sewage by irrigation has been carried on in this borough for the past 18 years. To say that no complaint as to the character of the effluent-water would be to say rather too much; but the complaints ceased when the council removed some agricultural drains into which the sewage-matter penetrated, and escaped without being duly purified, and the complaints have not since been audible."

Stoke-upon-Trent, 1876. — Sewage-irrigation proposed but not carried out. — Mr. W. Bagnall, the Town Clerk, writes: "The sewage is now dealt with by means of irrigation and downward precipitation on a small farm of 61 acres. The effluent is very satisfactory, the farm is let at a low rental of £120 a year."

Warwich, 1876. — Sewage dealt with by irrigation pumped upon 135 acres of stiff clay. Mr. Greenway, the Town Clerk, writes: "The Town Council have not altered their system of sewage utilization by irrigation, which was adopted many years ago. They believe it to be the best mode of dealing with this difficult subject. I must, at the same time, admit that the effluent is not at all so satisfactory as could be wished, but an increased filtering area, which has been recently constructed, will remove all difficulty in this direction. Financially, I cannot speak so hopefully; the result has been a heavy loss to the town."

Winchester, 1877. — A scheme is being promoted for pumping sewage to farm by lift of 100 feet, to be then treated by irrigation. Mr. Walter Bailey, the Town Clerk, writes: "The sewage of this city is utilized by means of irrigation with complete success. The land consists of 40 acres, a mile from the city. The sewage is conveyed by gravitation to the pumping-station, from whence it is raised by steam-pump to the land, 150 feet at the highest point. No nuisance is occasioned. There is no effluent-water to be dealt with. The system has been in operation about eight years, and gives great satisfaction. Apart from the pumping expenses, the farm is carried on at a profit, excluding the purchase of the land."

Wolverhampton, 1877. — Sewage dealt with by irrigation upon farm of 300 acres, purchased for £32,000. Mr. Berrington, the borough engineer, writes: "We have a farm of 300 acres, but the peculiar character of the sewage, being irony, coupled with the storm-water, has ruined it. If we had plenty of land, irrigation would turn out a satisfactory effluent. Notwithstanding that, we have a very small trout-stream into which we have to pour our effluent. My opinion is that while we have a sewage containing sometimes 62 grains of iron per gallon, we shall never turn out a safe effluent, for iron must get on to the land, and ruin it, or into the effluent, and spoil it."

Wrexham, 1877. — Here is a sewage-farm of 80 acres in lease to Corporation, under-let to Colonel Jones. House-water complained of by tenant. Colonel Jones now writes: "There are no complaints as to the effluent from the farm, which is carefully watched by the Corporation of Chester, from a natural anxiety about their water-supply, derived from the River Dee, below the confluence with the brook, which receives all the drainage-water from this farm. Of course, the fall in prices of agricultural produce has materially affected our finances. I still pay in rent, rates, and taxes nearly £5 per acre. I still keep accurate accounts, such as were published for the first seven years up to the date of my receiving the £100 prize in 1879, and keep my head above water. You will find a full report of everything in the *Journal of the Royal Agricultural Society*, Part 1, No. 31, 1880, and in pamphlet published 1885, by Potter, Wrexham, '*Will a Sewage-Farm Pay.*'"

COMMUNICATIONS

REPRODUCING EUROPEAN WOODWORK IN AMERICA.

SAN DIEGO, CALIFORNIA.

TO THE EDITORS OF THE AMERICAN ARCHITECT: —

Dear Sirs, — It is a little surprising that while the timber architecture of this country shows a constant progress towards the picturesqueness and variety which characterized that of the Middle Ages, which, in many cases, evidently form the *motif*, there is always a certain flimsiness about modern productions that contrasts very strongly with the massive and solid look of ancient erections.

While the old timber buildings of England, France and Germany are finished off with carvings of the greatest power and delicacy, there is always an aspect of dignity and repose which is entirely lacking in American dwellings, though in many instances our carvings are of the highest merit.

This should not be so. Timber here is as good and much more easily worked and procured than it ever was in Europe. A man should be as pleased to have a house that will last for four or five hundred years here as there.

I should like to see some houses built in America in exact *facsimile* of old European dwellings. I do not believe in slavish imitation, but a few houses such as these would help to get us out of our cardboard style, and then we could graft modern improvements on the ancient plan without sacrificing a substantial construction and appearance.

As far as details and ornamentation go, we cannot study too closely European patterns. Besides the exquisite grace and elegance, carving like that at Abbeville, Bourges, Lisieux, Hildesheim, Brunswick, Chester and Canterbury would impart to our buildings, such reproduction would help to preserve what otherwise must be lost. The destruction of masterpieces of timber-construction in Europe is appalling. Every year witnesses the levelling of hundreds of grand old manor-houses, town mansions and country cottages, without, in many cases, any record whatever. A few bits of carved wood are occasionally saved from the burning, but generally, only to be as effectually lost in private collections.

Will not American architects perpetuate and immortalize some of these priceless gems of art in modern villas, or even in business premises? Yours respectfully,

Evacustes A. Phipson.

DEVICE TO PREVENT WATER-BACK EXPLOSIONS.

Detroit, March 12, 1887.

To the Editors of the American Architect:—

Dear Sirs,— So much has been said and written about the trouble caused by the bursting and exploding of water-backs that I determined some time ago to overcome this annoyance, if possible, and I think I have succeeded perfectly; at least, I have been granted a patent for the contrivance.

The device is very simple, and consists of an air-chamber made of corrugated sheet-iron, placed inside of the water-back; when the water freezes it will expand .089 of its bulk; and as the compressibility of air exceeds this by far, an air-chamber of, say one by two inches, in an ordinary size water-back, will accomplish the object, and danger of bursting or exploding is averted, either from the expansion of ice or pressure of steam; to make sure, I have added a device in the shape of a plug placed in the top of the water-back, held in its place by a spring, which will allow the plug to raise up under a certain pressure of steam, thus acting as a safety-valve; when, then, the connections between the water-back and boiler are made with lead pipe, instead of iron pipe, all danger of bursting or exploding is averted.

I send you this, as I think it my duty to make it known to the public. Yours respectfully, H. E., *Architect.*

NOTES & CLIPPINGS

The Area protected by a Lightning-rod.— Herr Schiller, a well-known German architect, reports some facts which are of interest as indicating the radius of the circle of protection of good lightning-rods. On June 17 last, at the village of Mottingen, lightning struck a pear tree 33 feet high. On one side, 115 feet away, was a school-house with a rod 56 feet high. On the other side was a church, 328 feet away, and having a lightning-rod reaching up 154 feet. Both rods are well placed and had worked well when tested, and the level of the foot of the tree is about the same as that of the two buildings. It is evident, then, if the facts have been accurately reported, that the radius of the circle of protection is not more than twice the height of the rod.— *N. Y. Evening Post.*

Cleaning Stone-work in Large Cities.— The problem of cleaning the sculptured part of large public and private buildings which blacken and discolor so rapidly in our great cities has been carefully investigated in Paris by M. de Leibhabert, who puts his experience on record in the *Annales des Ponts et Chaussées.* He began at a number of masonry docks along the Seine. The black coating which covers the stone completely after a few years of exposure is first covered with a caustic paste consisting of soda and lime, which are mixed until they have the consistency of molasses. A little chloride of lime or perchloride of iron may be added. This paste is allowed to remain on the stone for two or three hours, according to the character of the stone and the state of the atmosphere. When it is washed off the stone is still black, but the coating has now been reduced to a condition in which it can be attacked by acids which before it resisted. After this preliminary operation a workman applies a mixture of sulphuric and hydrochloric acids, which is allowed to act for two or three hours. The mixture of the two acids varies slightly, according to the character of the rock and the inclination of its surface. Another set of men then wash the stone off with a jet of water. The process in Paris costs one-half of what is paid for scraping.

A Yankee Peddler's Cure for a Plague.— I was told a story of a "down-easter's" mode of creating a demand for a supply which, amid all the ingenuities of modern commerce, may fairly claim originality. One of the class called a "hickory-dealer," or seller of woodenware, came down to the South in the summer time with a well-laden wagon, but was destined to encounter a sweeping opposition in the yellow fever, which had commenced business about a week previous in such a wholesale way that the only wooden-ware in requisition was a coffin. The ravages of the plague were at this time so dreadful that it will be supposed there was a general tendency to try the most desperate, and absurd expedients to avert it, though many such proved but pioneers to its progress. This the peddler was aware of, so resolved, as regarded his own fortunes, to extract good from evil. Dressing himself as respectably as possible, he mounted his horse and rode up to a printing-office in Williamsburg, where, under an assumed name, he had a hundred bills struck off to this effect:

WANTED— immediately, wooden ware in any quantity, for the fever hospital in Philadelphia, such being found not to convey the infection. By order of the board of health. SETH ADAMS. N. B.— All persons cautioned how they use crockery, which is the cause of the plague to thousands.

Fifty of these placards he sent his boy to stick round the streets of a village lying in his road where the fever had begun to show itself. A discovery so important, so simple, and apparently in such close connection with a remedy, created an instant sensation. The doom of crockery was pronounced. Jugs, bowles, basins, teapots, and other utensils most esteemed or necessary were hurled out of the windows in showers. No grandmother's gift, no ancestor's relic survived this fall of china; the streets soon looked like a pottery after an earthquake About noon, when the work of destruction was at its height, a wagon made its way into the village with a man vociferating with all the power of his lungs "wooden-ware!" His arrival was hailed as a godsend; a crowd collected around him, as to a magician who brought a talisman, and in less than two hours his plague-averting platters were all disposed of at exorbitant prices.— *Boston Herald.*

TRADE SURVEYS

The clearing-house returns exhibit a slight falling-off in the volume of business. Railroad-returns are encouraging to investors, stock-holders, and to all the large interests concerned in the production of material for railroad construction. The general trade conditions remain favorable. Temporary influences are restricting trade. Permanent influences beneath them will bring demand up again to its strongest limits. The assured requirements of the country will engage every energy at command, and all that are being harnessed for early service. The salient features are these: Business has been checked by the change from an irrational to a rational basis of railroad management. No doubt the crude legislative efforts will be liberally supplemented by future Congresses as the requirements are made manifest by practical experience. The money-supply is equal to demand, and at present distribution to borrowers the dangerous point will not be reached this season. Even experienced financiers cannot tell when or how the volume of money may be decreased or increased. The presumption is the safest that the supply will decline, because of the increasing demands. Foreign money centres may be compelled to equalize exchanges in coin and thus protect us against the possible consequences of the depletion in progress. Borrowers are quick to return loans as soon as they have performed the services desired. Large outflows of capital are reported one month to the West to be followed next month by a return flow. The volume permanently invested in the West and South is steadily increasing, and fortunately is being invested on a basis, most of it, at least, of actual value. It is pleasing to note that real-estate values are preserved at a legitimate level. In Northern Alabama, and at one or two points in Kansas, a fever of speculation is apparent, but it affects limited areas. The closest investigation of the tendencies underlying the business world fails to unearth any really dangerous element or factor. The government has shown itself equal to the work of asserting its supremacy over railroad property. It has taken steps showing itself to be the willing servant of intelligent public opinion. Investors have, therefore, an additional evidence furnished them that investments are safe, that no reactionary or experimental legislation is probable, and that business ethics and standards of action will guide our law-makers.

The latest advices from manufacturers, railroad-builders, architects, and real-estate operators exhibit a steady growth of enterprise. That ten to twelve thousand miles of main track will be laid this year is evident from the fact that already 1,500,000 tons of steel rails have been contracted for, to be delivered this year, sufficient to lay over 16,000 miles of track. The reserve supply of 450,000 tons at least. Contracts for bridge work will be placed during the next three weeks which will furnish work enough for three month's production of our structural-iron making capacity. Contracts are now being placed for all manner of building-material to be used in the construction of mills, furnaces, factories, banks, warehouses and dwellings. The outside public world compare the volume of business now under passage to fairy tales, were it possible to picture it. Not less than 25 large blast-furnaces are to be built. The lumber-interests will be benefited, by the addition this season, of over 100 large saw-mills. The coal, ore, gold, silver, and copper mining interests will be strengthened by the addition of machinery sufficient to add 25 per cent additional facilities. Prices exhibit firmness and nothing more. Crude textile material is in abundant supply. Fuel supplies are guarded by combinations which will have but little influence in repressing healthy competition. The manufacturers of machinery have contracts in hand which forbid the possibility of dulness until after midsummer. The locomotive-makers and car-builders say so, too, and some of them are to-day soliciting a large labor supply. Small machinery is relatively in greater demand, because of the steady multiplication of petty industries all over the country. Pig-iron production is closely approximating 140,000 tons per week or 7,000,000 tons per year, while steel-rail production after this year will be equal as to capacity to 20,000 miles per year. The increase of motive-power and rolling-stock, or the increase of mechanical energy in the aggregate, can only be guessed at from figures like these. The builders can, therefore, take additional courage. The progress the country is making is not on borrowed capital. The percentage of borrowed money to actual wealth created is very small, and is growing less. Hence, even should our over-energy leap too far forward, the relapse will be so much the shorter because the nation will have no enormous debts to pay.